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ABSTRACT

The manual provides a review of trends in adapted computer technology as well as guidelines to the selection and use of computer technology in college programs serving disabled students. Changes in the second edition include a new section dealing with the computer access needs of the severely disabled, an enlarged product guide, a curriculum guide to development of courses in adapted computer technology, and the complete text of Section 508 of Public Law 99-506. An executive summary reviews the current state of adapted computer technology, its practicality in the educational and job environment, legal implications, and future trends. The first five chapters address specific access requirements for persons with visual disabilities, mild to moderate orthopedic disabilities, moderate to severe orthopedic disabilities, learning disabilities, and other disabilities. The remaining chapters have the following titles: "Profile of a High-Tech Center Director"; "Profiles of Disabled Persons Who Use Adapted Computer Technology"; "Funding the High-Tech Center"; "Computer Access, Disability and the Law"; "The Corporate Perspective"; and "Future Trends in Adapted Computer Technology." Appendixes provide a product guide to adapted computer hardware and software and an adapted computer technologies curriculum. A brochure describing the High-Tech Center for the Disabled of the California Community Colleges Chancellor's Office is also included. (DB)

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SECOND
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Computer Access in Higher Education for Students with Disabilities

A Practical Guide to the Selection and Use of Adapted Computer Technology

Carl Brown
and Colleagues

U.S. DEPARTMENT OF EDUCATION
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SECOND
EDITION

Computer Access in Higher Education for Students with Disabilities

EC221296

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Executive Summary

This summary will provide an overview of the current state of adapted computer technology, its practicality in the educational and job environment, legal implications and future trends.

The term "adapted computer technology" refers to any hardware or software system which, when used in conjunction with a microcomputer, provides systems access to disabled persons. The primary disability groups most likely to benefit from access to adapted computer technology are visually, orthopedically and learning impaired individuals.

In the current system of communication between people and computers, screen and keyboard are the primary channels of information exchange. Persons with disabilities, low vision or limited fine motor control, for example, find these channels of communication partially or totally obstructed. Traditional responses to this problem have typically involved specialized mechanical devices, exotic software or customized computer systems. Few of these solutions have proven effective in either the educational or work setting. Lack of cost effectiveness, steep learning curves and limited user productivity have rendered the implementation of such devices more a gesture of good will than a serious attempt to provide meaningful computer access in a process leading to productive, professional employment for disabled persons. Given the degree of technological sophistication previously available in the area of adapted computer access, this was probably all that could be reasonably expected under the auspices of education's mandate to provide "reasonable accommodation" and industry's affirmative action/equal opportunity employment guidelines.

Over the last two years, advances in microcomputer technology and the art/science of computer programming have given rise to a new generation of methods for providing computer access to disabled persons. A revolution has taken place in the efficiency, practicality and cost effectiveness of adapted computer technology. Most adaptations now exist as specialized computer programs rather than mechanical devices or customized computer systems. The practical results of these innovative new access technologies will have significant impact on the future of disabled individuals and on education and business.

Because this new generation of adapted computer access technologies is primarily software based, it allows full and unencumbered access to the complete range of commercially available software. In practical terms, this means that, for the most part, education and business can accommodate the special access needs of disabled computer users without modifying core curriculum software or business applications programs. Because adaptations are based in software, costs are dramatically reduced. Typical software adaptations cost one-half to two-thirds less than traditional hardware adaptations while providing significantly improved computer access and ease of use. The implementation of these new access technologies is taking place in many broad and diverse areas of both the educational and business community. Such educational institutions as the California community college system, University of California at Davis, Yale, Stanford and many other colleges and universities across the nation are actively involved in improving computer access for their disabled students through the use of adapted computer technology.

ES.2

A number of major computer manufacturers have made a strong commitment to the future of adapted computer technology. Digital Equipment Corporation, IBM and Apple Computer Corporation all have divisions dedicated to providing computer access for disabled individuals. IBM, through its Office of Product Initiatives for the Disabled, is actively sponsoring, developing and encouraging the manufacture of products which provide enhanced computer access for persons with disabilities. Apple Computer Corporation's Office of Special Education is dedicated to providing information about adapted computer technology to both education and industry, and has set new industry standards in access accomodation by including access programs for individuals with low vision, the deaf or hard-of-hearing, and the orthopedically disabled, as a part of the operating system for Macintosh computers.

In California, the State Department of Rehabilitation expressed its commitment to the future of adapted computer technology through a series of grants to the Community College Foundation totaling more than $5.5 million dollars. In cooperation with the California Community Colleges Chancellor's Office and participating colleges, these grants have established adapted computer technology centers at 51 of California's 106 community colleges, three California State University campuses, the University of California at Davis and other educational institutions across the state.

Although there are probably many effective ways to introduce adapted computer technology into a postsecondary educational setting, the California model has been in place for four years and provides an empirical, tested framework from which to begin.

The basic assumption of this model is that disabled students are presently, or will become, fully functional members of the community of students on campus. They will enroll in the same classes, be held fully accountable for academic standards and will progress towards graduation and employment. The purpose of this model is to provide functional computer access so that disabled students can: (1) fully participate in courses or career paths in which computers play an integral part and (2) avail themselves of the special benefits provided by computer access to students in general (i.e., word processing, research, computer assisted instruction, etc.).

In order to provided disabled students with training and experience in the use of computer adaptations, the California model establishes on campus a facility called The High-Tech Center for the Disabled. This facility is staffed by an Adapted Computer Technologies specialist and instructional aides. The Center offers specialized courses in the use of adapted access technologies appropriate to a particular student's disability. Generally, the use of appropriate adaptations is taught within the context of word processing. Upon achieving competency with his/her appropriate adaptation, the student may confidently enroll in courses which require computer access or use existing campus computer facilities. The underlying assumption of the California model is that a full range of adaptations identical to those learned in the High-Tech Center will be available at each major computer facility on campus. Where this is not possible, the High-Tech Center may also function as a resource center providing computer access for daily student needs.

Adapted computer technology functions most effectively with MS DOS based PC computers (i.e., IBM PS/2s, IBM PCs, AT&T PCs, Compaqs, HP Vectras, PC clones, etc.), Macintosh series computers, and to a lesser extent with Apple II series computers. This limitation in Apple II series computers is due in large measure to slow processing speed, the operating system architecture and constraints imposed by the characteristics of the processor chip used. The Macintosh computer is potentially capable of supporting an elegant array of adapted computer technologies. Although few adaptations currently exist for the Macintosh, those that do are quite good, and more will undoubtedly become available.

When used as a terminal in a mainframe or minicomputer network, PCs will generally support adaptations while running in terminal emulation mode under

MS DOS. This is an important consideration since software based adapted computer technology is virtually nonexistent for mini and mainframe computer systems using dumb terminals (DEC VT-240s or IBM 3270s, for example).

Adaptations for blind computer users work exceptionally well on PC computers, moderately well on Apple IIe's, and will soon be available for the Apple Macintosh. Systems for blind computer users are composed of two parts: (1) specialized software capable of "reading" text displayed on the computer screen and (2) speech synthesizers capable of "speaking" what is being "read." There are a variety of screen reading programs and speech synthesizers available. DECtalk, manufactured by Digital Equipment Corporation, is generally considered to be the best speech synthesizer currently manufactured. Blind computer users can be quite successful with tasks which involve text and/or numbers.

Successful applications might include but are in no way limited to accounting, spreadsheets, database management, word processing, computer programming and data entry. Computer applications which depend heavily on graphic presentations (i.e., computer assisted design, statistical information displayed as charts and graphs, etc.) remain a problem as the present generation of screen reading programs provide no methods for interpreting graphic displays.

Adaptations for individuals with low vision work very well on the PC and Macintosh computers. Good low vision adaptations also exist for the Apple II series and many "dumb" computer terminals although they are hardware based and rather expensive. Low vision adaptations are available for both the PC and Macintosh computers which provide magnification of both text and graphics on the computer screen. Low vision adaptations for the Apple II series or other computer terminals accomplish much the same thing but do so

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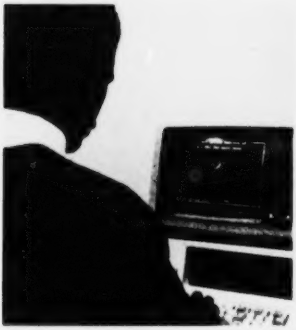
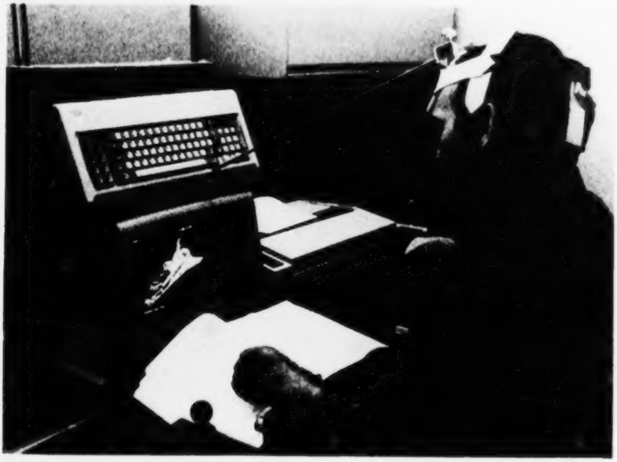




by presenting the enlarged image on a separate display monitor. When provided with appropriate adapted computer technology, individuals with low vision can enjoy full access to campus-wide computer resources.

Adaptations for individuals with mild to severe orthopedic disabilities exist and work well on PC, Apple II series and Macintosh computers, although the most sophisticated adaptions are still only available for the PC. These adaptations are primarily concerned with reducing the difficulty experienced by individuals with missing limbs or limited fine motor control in accessing the keyboard. Simply overcoming keyboarding difficulties, however, is not enough to provide effective computer access for moderately to severely orthopedically disabled persons. Another very significant area of adaptive intervention concerns typing speed. In order to be competitive in either the educational or job environment, the orthopedically disabled individual must be able to produce written material quickly. "Smart" word processing systems available for PC computers use artificial intelligence technologies to anticipate and predict word choices based on minimum text input. Using these systems, individuals with significant orthopedic disabilities can increase their typing rate by as much as 75%.

Adaptations for individuals with learning disabilities, primarily visual and auditory processing deficits, can be very successfully introduced in both the PC and Macintosh environments, and used with moderate success on Apple systems. A visual processing deficit frequently manifests itself as a chronic, intermittent inability to receive and/or express written information in an organized and sequential manner. For a student in post-secondary education or an employee in a text-oriented job setting, the effects of this disability can be devastating. Using a combination of adaptations including smart word processors, real-time spell checkers, screen reading systems and advanced speech synthesizers, an adapted writing environment can be created which is auditorially rather than visually oriented. In this environment, the user can hear what he/she has written and so transfer the error identification/correction process to an auditory mode where it can proceed unobstructed by the effects of the visual processing disability.

Just as a mechanical prosthesis becomes a natural extension of its wearer, compensating for a limb lost to accident or injury and restoring the ability to carry out the normal activities of daily living, so a computer adaptation quickly becomes an extension of its user, an electronic prosthesis effortlessly compensating for and restoring his/her ability to use a computer.

Avoiding Obsolescence

ES.9

A serious and quite legitimate concern of many administrators faced with the task of choosing and purchasing sophisticated computer hardware and software is the rapidity with which such equipment regularly becomes obsolete. The all-too-frequent response to concerns about obsolescence or seductive rumors about what's "just around the corner" often results in an endless series of postponements to the establishment of adapted computer technology on campus.

There are two distinct types of obsolescence: technological and functional. Technological obsolescence is a research driven phenomenon which generally provides a better way to do an existing task. One solution to the issue is simply to accept the periodic technological obsolescence of existing adaptations as a part of the cost of doing business. Advances in adapted computer technologies sufficient to warrant replacement occur approximately every three years or so if previous cycles of improvement are reliable indicators. Functional obsolescence is task related. A wrench is the ideal tool for the task of loosening or tightening a nut. If, however, the nut is replaced by a rivet, the wrench becomes functionally obsolete.

Although technological obsolescence seems unavoidable, careful initial planning can forestall an adapted computer device's functional obsolescence for many years. By providing effective, generalized access to campus computer facilities, the basic tasks which must be accomplished to complete a post-secondary educational program will be within the grasp of disabled students. Basic educational tasks, unlike technology, change very little from year to year. The effectiveness with which disabled students are able to use these adaptations to complete academic tasks will have a direct bearing on the functional life expectancy of such equipment. The more effectively an adaptation meets a need, the longer it can be used.

Computer Access, Disability and the Law

As new technologies are introduced into the marketplace and become commonplace in post-secondary education, the challenge to accommodate disabled students is presented to colleges and universities on a daily basis. Many new adapted computer technologies clearly do not place an undue financial burden or hardship on an institution. The issue is how to quickly and easily make it possible for students with disabilities to take advantage of these new technologies.

Not only do colleges and universities have a historical commitment to providing a comprehensive education to all matriculating students, but legal requirements exist which mandate that institutions provide equal access to educational opportunities for students under the Civil Rights Act of 1964 and, more specifically, under Section 504 of the Rehabilitation Act of 1973 as amended [29 U.S.C. sec. 794]. This Act describes "reasonable accommodation" as the method for ensuring the nondiscrimination of disabled persons. Across the country, institutions have taken broad steps to make education more accessible to students with disabilities. The decade of the 1970's saw great emphasis on the removal of architectural barriers on campuses so that students in wheelchairs could get into classrooms. Elevators were built so that physically handicapped students could access classrooms on the second or third floors of campus buildings and attend class. States now have Architectural Review Boards and extensive requirements for the construction of buildings and pathways which accommodate the disabled as a general rule. Reflecting on what was built in the past, ES.11 how could our planning have been so shortsighted as to have constructed engineering centers or humanities laboratories from which students with physical disabilities were barred by oversights in design?

Now that adapted computer technology, based primarily in software, permits full access to commercially available and professor-authored software programs, individual microcomputers and networks, it is reasonable to expect institutions to take proactive steps to accommodate students with disabilities. There can and most certainly will be legal consequences in not doing so, as equal access and equal opportunity continue as guiding principles in college admissions and academic participation.

As a case in point, in the 1979 Supreme Court case *Southeastern Community College v. Davis*, our highest court recognized emerging needs of the disabled in terms of advances in technology:

> We do not suggest that the line between a lawful refusal to extend affirmative action and illegal discrimination against handicapped persons will always be clear. It is possible to envision situations where an insistence on continuing past requirements and practices might arbitrarily deprive genuinely qualified handicapped persons of the opportunity to participate in a covered program. Technological advances can be expected to enhance opportunities to rehabilitate the handicapped or otherwise to qualify them for some useful employment. Such advances also may enable attainment of these goals without imposing undue financial and administrative burdens upon a state. Thus, situations may arise where a refusal to modify an existing program might become unreasonable and discriminatory. Identification of those instances where a refusal to accommodate the needs of a disabled person amounts to discrimination against the handicapped continues to be an important responsibility of HEW [442 U.S. at 412-413].

ES.12

Further, in *Alexander v. Choate* [105 S.Ct. 712 (1985)], the Supreme Court states:

> Discrimination against the handicapped was perceived by Congress to be most often the product not of invidious animus, but rather of thoughtlessness and indifference—of benign neglect . . . For example, elimination of architectural barriers was one of the central aims of the Act, yet such barriers were clearly not erected with the aim or intent of excluding the handicapped [105 S. Ct. at 718-19].

Looking ahead to the year 2000, it is essential that we consider reasonable accommodation as a regular part of institutional planning. Returning now to adapted computer technology, responding to the microcomputer onslaught in the college classroom and campus environment, simple steps can be taken to ensure that students with disabilities can use microcomputers as an ongoing part of their college education. In many cases, accommodation is simple. What can institutions do? First, in planning microcomputer and mainframe use at an institution, consider that an ongoing portion of students will need to be reasonably accommodated due to visual, physical, hearing or learning disabilities. Design an accessible system. Next, keep abreast of software packages that permit reasonable accommodation for the disabled and allow non-disabled persons access as well. Third, it is critical that institutions pay particular attention to how public information is made available to the campus and at-large community and, wherever public information is available, ensure that persons with disabilities have access to this information as equal members of the college community. For example, if students are required as part of the college curriculum to access LEXIS, DOW JONES or ERIC databases, questions such as "how will a blind student use this terminal" or "is the library's computer which contains ERIC accessible to a student in a wheelchair" must be answered. If all students at an institution are given a microcomputer or are required to use ones available in the campus center, student lounge or dormitory, how will disabled students be accommodated? Adapted computer technologies provide answers to these questions and enable institutions to provide the very best through hardware and software accommodations that are becoming increasingly commonplace.

Finally, in relating these emerging new technologies to the goals and objectives of affirmative action, Section 504, and the U.S. Department of Education's regulations on Section 504 in regard to program accessibility and the provision of auxiliary aids to students with disabilities (34 C.F.R. Part 104), standards have now been developed which apply to adapted computer technologies. Quoting from a recently released report produced jointly by the Department of Education and the General Services Administration:

> On October 21, 1986, the Department of Education (ED) and the General Services Administration (GSA) were directed by Congress (Public Law 99-506) to develop agency procurement guidelines to ensure access to electronic office equipment by individuals with disabilities.

The report continues:

> In 1986, Congress re-authorized the Rehabilitation Act of 1973, as amended, (Public Law 99-506) adding Section 508 on electronic equipment accessibility "... to insure that handicapped individuals may use electronic office equipment with or without special peripherals." Congress has mandated that guidelines for electronic equipment accessibility be established and adopted and that agencies shall comply with these guidelines with respect to electronic equipment, whether purchased or leased.

ES.14

These clearly defined access criteria, usage requirements, guidelines and related access issues comprise standards which will, in short order, become law or administrative rulings. Applying the likelihood of this kind of legislation to the needs of disabled persons, it is probable that institutions which receive federal funds and which require computer access for all students will need to prepare for such standards very soon.

Future Trends and Issues

New trends in academic computing hold both promise and peril for disabled students in post-secondary education. In order to better manage existing computer resources, many colleges are developing networked systems which link a wide range of micro, mini and mainframe computers into a single cohesive system. The benefits of such systems can be enormous: common access to electronic mail, research databases, centralized word processing, computer assisted instruction, course registration and library resources, to name a few. An alarming factor in this rush for control and management of burgeoning computer resources is the limited amount of consideration given to the impact of such networks on computer access for disabled students. A number of considerations must be taken into account when such systems are under consideration:

- **How will networking software affect existing computer adaptations?**
- **If centralized word processing is to be introduced, will the system employ screen formats which can be accessed by systems for blind computer users?**
- **If terminals rather than PC type microcomputers are the primary workstations, how will access for low vision, blind and orthopedically disabled students be provided?**

These are but a few of the questions which must be carefully considered when planning the installation of such systems.

With the advent of high resolution color displays and laser disk technologies, all indications point to a growing emphasis on graphically oriented computer displays. This could have significant adverse impact on visually impaired individuals. The Apple Macintosh computer is a classic example of a state-of-the-art graphically oriented computer system, which, until recently, was totally inaccessible to blind computer users. The bit-mapped screen displays could not be read by any existing systems for blind computer users; the mouse interface was entirely dependent on visual orientation. The icon based system commands were graphically rather than textually configured and could not be interpreted by previous screen reading systems. It is now well within the range of technological possibility to design such systems with the means to support adaptations for blind users. However, such design considerations must be incorporated into the basic architecture of the system, not added on at a later date. As more and more sophisticated computer systems are developed, awareness of access requirements for disabled computer users during the early design phases of such machines will become progressively more critical.

ES.16 Computerized versions of most major placement tests are now available or being actively developed by large testing companies. If, and we have no reason to believe otherwise, computer based testing becomes the national norm, how will computer access be provided to disabled individuals wishing to take such tests?

Much vital, public information now only exists electronically in massive, federally funded computer databases. With such databases rapidly becoming the exclusive domain of vast quantities of public information, are they not, in fact, a new kind of public library? If they are, in fact, public libraries dependent upon federal funds, then they must be readily accessible to all citizens, including disabled citizens, under Section 504 of the Rehabilitation Act of 1973. How will such access be provided?

Obviously, questions of enormous magnitude remain to be answered in the decade ahead. The opportunities for disabled individuals to succeed in our technologically advanced society have never been greater.

Introduction

The High-Tech Center for the Disabled

of the California Community
Colleges Chancellor's Office

The High-Tech Center for the Disabled

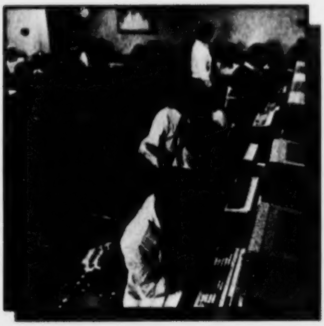
Success in post-secondary education depends increasingly upon access to computer systems. Students with visual, physical, learning, or cognitive disabilities may require the assistance of special access technologies in order to effectively use computer systems. The purpose of the High-Tech Center program is to provide disabled students with access to technologies which allow full participation in post-secondary education and employment settings.

The High-Tech Center program is a cooperative undertaking between the California Community Colleges Chancellor's Office, the California State Department of Rehabilitation, the California Health and Welfare Agency, the Community College Foundation, the state-wide system of California Community Colleges, and other participating agencies. The High-Tech Center Training Unit, located in Sacramento, California, is the central support facility for the state-wide network of High-Tech Centers.

The High-Tech Center Training Unit

The Center conducts specialized trainings in the areas of Adapted Computer Technology and Acquired Brain Injury/ Learning Disability software applications. It also provides daily technical support to more than one hundred and fifty professionals working at High-Tech Centers across the state. Additionally, the facility publishes and distributes the bi-monthly High-Tech Center News, and operates an electronic bulletin board system to further enhance communication between field sites and the Center. Both the newsletter and the bulletin board system are dedicated to issues related to computer access for the people with disabilities.

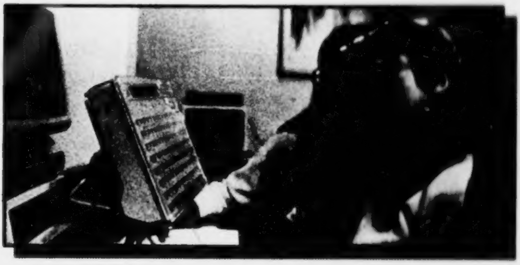
The High-Tech Center also conducts ongoing research into new and emerging access and instructional technologies and thus functions as an information resource for the entire post-secondary educational system.



These services are offered at no charge to all California Community Colleges and participating educational agencies.

Adapted Computer Technology

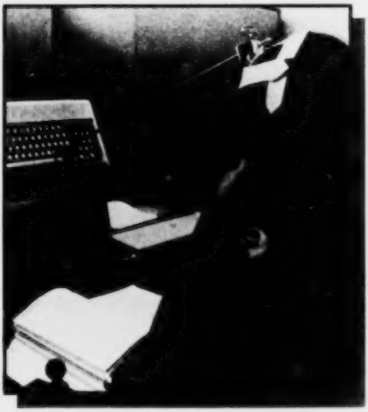
Persons with orthopedic, visual, or learning disabilities frequently experience great difficulty either seeing the screen or manipulating the keyboard. Adapted Computer Technology (ACT) refers to any computer program or device which restores an individual's ability to see a computer screen or use a keyboard. The ACT component of the program employs high-quality software adaptations which are easy to use, commercially available, and function transparently with commonly used software programs (Lotus®, WordPerfect®, dBASE®, etc.)



Orthopedic Disability

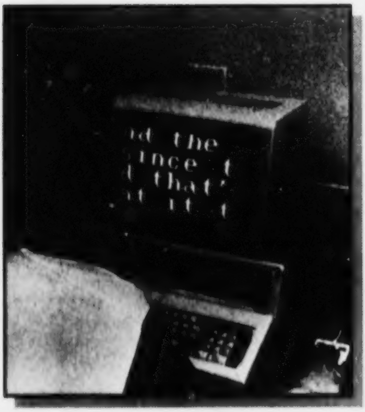
The ACT component provides specific adaptations for students with mild to moderate orthopedic disabilities. Software and hardware systems provide alternative computer keyboard methods. Depending upon the nature and severity of the disability, adaptations might be as simple as stopping the automatic key repeat feature found on many keyboards or as complex as combining predictive "smart" word processing systems, automatic spell-checkers, and keyboard control programs to produce highly automated writing environments.

The High-Tech Center has been instrumental in introducing "smart" word processing systems. A "smart" word processor analyzes the content and word frequency patterns of the sentence under construction, anticipates the entire word or phrase based on the first two or three letters, then completes it with a single keystroke.



Visual Disability

For students with low vision, the ACT component provides a variety of effective, easy-to-use methods for viewing enlarged text directly on the computer monitor. Individuals with low vision gain access to the whole gamut of personal computer programs when utilizing adaptations that enlarge screen text and graphics through a wide range of magnifications. Low-vision adaptations are remarkably easy to learn; most users master the fundamentals in less than fifteen minutes.



Advanced speech synthesizers combined with screen reading programs enable blind persons to "see" computer screens through auditory feedback. Synthesizers "speak" what screen-reading programs "see" on the screen. This combined technology enables persons with visual disabilities to write documents with word processors, enter numbers in spreadsheets, retrieve data from databases, or use a host of other common computer applications.

Synthesizer and screen reader combinations also allow persons with learning disabilities to hear what they have written. Moving error identification and correction processes from a visual mode to an auditory mode can be enormously useful to persons with visual processing deficits. Enlarging the size of the screen text and/or changing the background or text color also enhances visual perception.

Deafness or Hearing Impairments

Persons who are congenitally deaf and those with limited hearing often experience difficulty gaining facility with written language. In addition to special word processing systems, the ACT component employs software which translates written English into graphic finger spelling signed on the computer screen. With this configuration vocabulary lists, for example, might be entered into the computer to provide practice with both the signed and English orthographic versions of a given word.

Acquired Brain Injury

The Acquired Brain Injury/Learning Disabilities (ABI/LD) component of the High-Tech Center dedicates itself to improving academic performance, personal productivity and employability of students with learning disabilities and/or acquired brain injuries.

The Consortium for the Study of Programs for the Brain Injured defines acquired brain injury (ABI) as "an acquired impairment of medically verifiable brain functioning." Many students with acquired brain injury (ABI) experience deficits in attention and concentration. Extraneous stimuli distract them easily and they have difficulty concentrating. Memory deficits are common and result in difficulty acquiring new information. Other areas of cognitive processing which may be affected by ABI include: speed of thinking, receptive and expressive language skills, psychosocial behavior, mental flexibility, impulsivity, motor/movement, vision, hearing and other physical abilities.

Learning Disabilities

In the California Community College system, learning disability (LD) in adults is defined as "a persistent condition of presumed neurological dysfunction which may also exist with other disabling conditions. This dysfunction continues despite instruction in standard classroom situations." Students with learning disabilities demonstrate a number of common characteristics. While no one student will exhibit all of them, some of these characteristics include: difficulty focusing and sustaining attention, inconsistent performance on tests, limited expressive or receptive vocabulary, misnaming of objects using a similar but incorrect word, difficulty repeating auditorily presented material, difficulty following complex oral directions, difficulty with reading and written language, and problems with fine-motor movement.

ABI/ LD Objectives

The development or retraining of cognitive, educational, study, and productivity skills enhances students' success in mainstream courses and work environments. The ABI/LD software and activities are used in conjunction with other academic support services on campus. Computer software programs provide skill development in four areas: Foundation Skills, Problem Solving and Learning Strategies, Educational Skill Building, and Productivity and Compensatory Skills.

44

Foundation and Problem Solving Skills

Attention, concentration, memory, differentiation, and sequencing make up basic cognitive processing skills. These **foundation** skills are trained initially to ensure full participation by students in the learning activities that follow. Some programs were specially developed for students with brain injuries, but most are commercially available.

Problem solving and learning strategies are taught to help students retrieve information and solve a wide variety of practical, educational and life skill problems. Computer programs in this area build from simple to complex concepts. They focus on learning to select, combine and implement problem solving and learning strategies.

A5.

Educational and Productivity Skills

Computer software provides instruction in basic **educational** skills using tutorials, simulations and practice. Students learn to apply study skills, information gathering and reference use to actual coursework. These educational tasks incorporate language arts, reading and mathematics processes.

Productivity and Compensatory Skills software trains or supports personal productivity, both for educational activities in mainstream classes and in work related needs. Students practice tasks requiring executive functions such as organization and managment. Compensatory strategies and software help students increase their task efficiency and work completion. Software includes word processors, spell checkers, outliners, calculators, budget managers, and personal time management systems.

Campus Resource Integration

Staff from all High-Tech Center sites are trained to coordinate software with existing educational resources in order to provide a comprehensive program for students. This coordinated system provides students with the technological tools necessary to work toward independence and greater academic or vocational success.

A Message from the Director

Carl Brown is Director of the Office of Adapted Computer Technology for the California Community Colleges Chancellor's Office and coordinator of the High-Tech Center for the Disabled. "The High-Tech Center program is an outstanding example of what can be accomplished when state agencies work cooperatively to enhance the educational and employment opportunities of persons with disabilities. The assistive computer technologies provided by this program point the way towards a bright new future for persons who are deaf or hard-of-hearing, have acquired brain injuries, or have visual, orthopedic, or learning disabilities."

Notes

Notes

Lotus is a registered trademark of Lotus Development Corporation.
Wordstar is a registered trademark of MicroPro International Corp.
dBase is a registered trademark of Ashton-Tate.
IBM PC is a registered trademark of IBM Corporation.
Apple is a registered trademark of Apple Computers, Inc.

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Before We Begin

Welcome to the Second Edition of Computer Access in Higher Education for Students with Disabilities. Although this new book contains many updates to access technologies discussed in the original edition, its principle addition is an entirely new section dealing with the computer access needs of the severely disabled. Also, the product guide has been enlarged to include several new access programs and devices, plus a curriculum guide to development of courses in adapted computer technology has been included, as well as the complete text of Section 508, the so-called "electronic curb cut" legislation.

Before we begin exploring the history, philosophy and use of adapted computer technology, it would be well to understand the basic premise upon which this guide has been constructed.

1.1 In a word: practicality. This guide will probably be unlike anything you have previously used. In order to avoid the technological obsolescence such guides are subject to, we will define the functions an adaptation must be capable of in order to meet the special needs of a disabled computer user. Those needs, unlike the rapidly changing technological possibilities of computer adaptations, remain fundamentally constant. If those special access needs and requirements are thoroughly understood, new adaptive computer technologies can be evaluated within the relatively stable framework of the unique needs of disabled computer users.

This guide offers proven guidelines for making the kinds of basic decisions about adapted computer technology those in the helping professions must produce on a daily basis:

- **What should I buy so that a student with low vision can use the computer?**

- **What adaptations are available for students with learning disabilities?**
- **How can I provide computer access to students with limited fine motor control?**
- **What adaptations are available to help improve language skills in students who are congenitally deaf or hard of hearing?**

Rather than providing a comprehensive catalogue of all available adaptations for disabled computer users, this guide presents a carefully selected array of adaptations which work extremely well for disabled students in post-secondary education. In addition to reliable guidelines for evaluating adapted computer technology, you will find an insert to the guide detailing specific product recommendations, vendor names and current prices as of this writing. The manual also includes general guidelines for instruction in the use of specific classes of adaptations (low vision adaptations, learning disabled adaptations, etc.). You will find chapters discussing the legal implications of computer access, funds acquisition, student and staff profiles, the corporate perspective and future trends in adapted computer technology. *1.2*

In formulating this guide, our basic assumption was always that both staff and student had little or no computer experience. Therefore, explanations and training guidelines are presented with a minimum of technical jargon.

One final point: unlikely as it may seem, adapted computer technology is about people. It is also about opportunity and ability and persistence. Most importantly perhaps, it is about a previously unavailable resource, a resource which can provide vast numbers of people who have disabilities with the opportunity to compete and succeed as equals in the academic and job environment.

Beginnings

The birth of the High-Tech Center for the Disabled was made possible through a combination of factors which included the maturing of microcomputer technology, a fair amount of serendipity and a supportive college administrator who was willing to take a risk.

In the Spring of 1984, the Disabled Students Services program at Monterey Peninsula College began offering courses in word processing to students with disabilities. Within the first week, the difficulty of using microcomputers, even for students with relatively mild orthopedic disabilities, was obvious. How, for example, does a student who has only one finger with which to type hold down two keys at once? How can a student with limited fine motor control avoid pressing an unwanted key? How can a student with low vision see what is appearing on the computer's screen? Needless to say, we had many more questions than answers.

Through trial and error, center staff quickly developed partially effective solutions to some of the more acute access difficulties. Feeling confident that we had solved the problem of providing computer access to disabled students, we resumed the word processing courses, and the six disabled students who were enrolled completed them successfully. The following semester, fourteen disabled students enrolled in the course. In the summer, over thirty requested enrollment. On a rising tide of excitement, enthusiasm and some panic, we began trying to understand what was happening. Although our efforts to provide computer access to disabled students continued in a random and somewhat erratic fashion, we persisted in our view of solving the problems of computer access as secondary to teaching a course in word processing. Meanwhile, out in the real world, disabled individuals who had never considered post-secondary education were enrolling at Monterey Peninsula College in order to learn word processing with adapted computers. And they were staying on to become participants in mainstream courses.

When demand for the course reached epic proportions, it was time to stop and think carefully about what was happening and what we were doing. We had created a course in word processing for students with disabilities. We had developed a few techniques and tools which made computer access easier for students with certain kinds of disabilities. That we had tapped a tremendous unmet need was obvious, but what was it? Upon closer examination, it became apparent that what students were coming for was not so much to learn word processing as to learn how to use the adaptations which gave them access to computers in general. We had tapped the enormous desire many disabled individuals felt to use computers. Much to our surprise, we discovered that we were in the business of providing computer access to students with disabilities. 1.4

Over the course of the next few weeks, a number of decisions were made which were to have far reaching consequences on the future of adapted computer technology at Monterey Peninsula College, the California Community Colleges Chancellor's Office, the State Department of Rehabilitation and the United States Department of Education.

After careful consideration, we determined that a real need existed for a systematic program of identification, testing and implementation of adapted computer technology at Monterey Peninsula College. And here we made a decision which dramatically altered our approach to adapted computer technology. Rather than build a facility by acquiring traditional adaptive devices as if they were the only options available, we decided to determine what an ideal adaptation ought to do and then set out to find or create it.

But first there were the twin issues of project approval and funding.

As a group, directors of Disabled Student Services programs in the California community colleges are a dedicated and resourceful collection of individuals intensely committed to supporting the success of disabled students in post-secondary education. As a group they are, as well, shockingly underbudgeted for the task at hand. The director of the disabled students program at Monterey Peninsula College was a staunch supporter of new technologies for the disabled. When we met to discuss the prospect of developing such a program, she was immediately enthusiastic about the concept and somewhat pessimistic about the availability of funding. Project approval was awarded immediately; funding for equipment and supplies would have to wait. But, as it turned out, not for long. A one-time windfall funding source became available within the month. Rather than spend this surplus on other equally worthy projects, she elected to gamble on the future, and so the High-Tech Center for the Disabled was born.

What Is Adapted Computer Technology?

In the early 1960's, when microcomputers first began to appear, they were hailed as the great equalizers—the technological breakthrough which would at last allow disabled individuals to compete as equals with their non-disabled peers. Until recently, the unfortunate reality of computer use by the disabled has been a history of frustration and disappointment. This was due, in large measure, to a basic design feature of computers in general.

Screen and keyboard are the primary channels of communication between people and computers. Persons with orthopedic, learning or visual disabilities frequently experience great difficulty seeing the screen or manipulating the keyboard. In the past, this often presented an insurmountable barrier to successful use of microcomputers by disabled individuals.

Adapted computer technology, as defined by the High-Tech Center for the Disabled, refers to any computer program or device which restores a disabled person's ability to see the screen and use the keyboard. Within the context of adapted computer technology, however, "seeing the screen" and "using the keyboard" take on new meaning and dimension undreamed of by designers of the original screen/keyboard interface between people and computers.

Given the advanced state of microcomputer technology and programming environments, recent breakthroughs in manufacturing procedures and the tremendous wealth of new and emerging software, we felt the time was right for a radical change in the traditional approaches to providing computer access to persons with disabilities. We established as our primary goal the replacement of expensive hardware-based computer modifications with high-quality software adaptations. These adaptations had to be easy to use and commercially available. Given the current state of microcomputer and software technology, we felt that these adaptations ought to cost one-half to two-thirds less than previous adaptive devices.

With these goals in mind and our experiences with the needs of disabled students as guidelines, we formulated the following set of criteria for evaluating possible adaptive technology.

Every adaptation employed by the High-Tech Center must:

- **Provide the disabled individual with significantly improved access to microcomputers.**

- **Function with industry standard software such as Lotus, WordStar and dBASE.**
- **Function concurrently and harmoniously with many other adaptations. Disabling conditions frequently require the simultaneous use of several adaptations in order to restore full access.**
- **Be easy to teach, learn and maintain. With rare exception, the disabled individual should be trained in less than thirty minutes.**
- **Be affordable—generally, less than three hundred dollars.**
- **Function on the IBM PC, PC compatible, Apple IIe or Macintosh computer (although a particular adaptation might not necessarily be interchangeable between PC and Apple computers).**

The intent of our criteria was to make adapted computer technology available as a practical tool for the disabled individual in both the college and work environment. Each item in our list of criteria represented an essential element in the overall structure of adapted computer technology. In order to better understand the overall concept of the High-Tech Center, it is important to be aware of the reasoning behind each of these criteria. I.7

Providing disabled individuals with significantly improved access to microcomputers was vital. Learning to use a computer can be a somewhat perplexing experience for anyone. We saw disabled individuals as being doubly burdened, first by the problems everyone typically experiences in learning to use a computer and secondarily by the inherent difficulty of using the currently available adaptive computer devices. The thousands of tiny frustrations associated with the constant use of clumsy adaptations regularly prevented disabled students from enjoying the labor saving benefits of computer access. The need for much more effortless, elegant and natural adaptations was obvious. Fortunately, with the advent of new microcomputer technologies, such adaptations were now possible.

A tremendous library of software exists for microcomputers: word processing, spread sheets, programming languages, accounting, communications, database management, computer assisted instruction and computer assisted design to name a few. To fully open the world of possibilities available to disabled students through access to microcomputers, it was essential that we introduce adaptations which would function harmoniously with commercially available software. There was also a deeper philosophical position underlying the need for access to commercially available software.

We saw the High-Tech Center as a training facility rather than a cloister. Our expectation was that disabled students would come to the High-Tech Center to learn the use of computer adaptations appropriate to their disability. When a functional level of competency had been attained, disabled students would make the transition to mainstream courses where, if computers were used, adapted computer technology would be available at the various computer facilities on campus.

In providing access to commercially available software and transitioning disabled students into a wide range of courses which used computers (i.e., accounting, drafting, word processing and computer science) we hoped to begin breaking down a long standing equation concerning computers and the disabled. The equation went like this: Disabled Person + Computer = Computer Programmer. We felt that access to adapted computer technology could provide many other career opportunities in addition to computer programming.

Our decision to seek or develop adaptations which

could function together concurrently and harmoniously reflected a major design component of the High Tech Center: adaptations must be adaptable to various disabilities. Disabling conditions came in a variety of configurations; it made sense that adaptations should also. In order to meet the special access requirements presented by combinations of disabling conditions, we wanted to develop a set of adaptations which could be assembled like building blocks into a myriad of different configurations. This would allow us to meet the access needs of students with multiple disabilities, but it would also address a more subtle problem.

Very rarely do disabling conditions such as blindness, low vision or mild to profound orthopedic disabilities take place as discrete, self-contained phenomena. More typically, even a single disabling condition has multiple secondary consequences directly or indirectly related to the disability. Many of these I.10 consequences require intervention in order to provide effective computer access. A few examples: the blind computer user who unknowingly triggers the automatic key repeat function by not releasing the keys quickly enough, the learning disabled computer user with limited fine motor control, the orthopedically disabled computer user who has been educationally disadvantaged and needs continuous spell checking in order to compose a sentence.

Although it had long been possible to meet, after a fashion, the gross access requirements of disabled computer users, we felt that the myriad of small difficulties created as a secondary consequence of the disability must be removed in order to build confidence and create truly unobstructed computer access. By developing a library of adaptations which could be dynamically assembled to address these requirements, a much higher level of computer access could be achieved.

In our experience, one of the principal roadblocks to the widespread use of adapted computer technology was the expense and complexity of early computer adaptations. Disabled Student Services program directors and members of the helping professions in general are intensely busy people. A computer adaptation which requires a month or more of an instructor's time to learn and additional months to teach is not an effective tool. Even the most dedicated of staff simply do not have enough hours in a day to deal with such equipment. The hallmark of advanced technology is simplicity and ease of use. We saw no reason why adapted computer equipment should be exempt from such a standard. The majority of program administrators, instructors and helping professionals are not computer technicians. Many are wary of the historical complexity of computer adaptations in general. Unfortunately, this wariness all too often translates itself into a reluctance to provide computer adaptations on campus. It was evident that, to be effective, computer adaptations must not require excessive time or technical expertise from staff or students.

Cost of adapted computer equipment was an equally problematic issue both for colleges and the ultimate users of adapted equipment, disabled students themselves. Adaptations with twenty-five hundred to four thousand dollar price tags might be affordable in limited quantities to colleges or universities, but few, if any, disabled students in post-secondary education would be able to purchase such a device, to say nothing of a computer to go with it. It is during a disabled student's term in post-secondary education when continuous access to such equipment, a degree of access which can only be practically attained through ownership, may be most critically needed. We determined that computer adaptations must be affordable to colleges and more importantly to disabled students. There

is very little point in teaching a disabled individual to use a splendid adaptive device which he or she can never afford to purchase.

Our approach to determining which computing environment to develop adaptations for was somewhat eclectic. The traditional computing environment for disabled students was the Apple computer. Rather than begin with the assumption that we would use Apple computers, we established a set of criteria defining the level and quality of adaptations we proposed to provide and then went looking for a computing environment which would support our criteria. We found IBM PC and PC compatible computers ideally suited to our needs. The MS DOS operating system, expanded memory and faster processing speed provided the sophistication required to support advanced computer adaptations. In line with our intention of providing meaningful computer access, we found PC computers dominating the business world and rapidly replacing Apple computers in post-secondary education. They were affordable, easy to repair and much nearer to state-of-the-art microcomputer technology. We would focus primarily on PC computers while continuing to explore effective adaptations for Macintosh computers.

In this way, we established the conceptual framework of the High-Tech Center for the Disabled at Monterey Peninsula College. During the next two years, we explored, experimented, tested and evaluated a variety of software and hardware adaptations. Many were failures. Some worked moderately well under controlled conditions. A few proved to work very well indeed.

The following pages summarize the use of the best of these practical and effective adaptations for low vision, blind, learning disabled, deaf and hard of hearing and mild to moderately orthopedically disabled individuals. It is our most sincere hope that removing the guesswork and uncertainty from the process of implementing adapted computer technology will usher in a new era of computer access for disabled students.

In support of this exciting new opportunity, the California Community Colleges Chancellor's Office has established the statewide Office of Adapted Computer Technology in Sacramento, California. Its task is to provide support and training to California's 106 community colleges in the area of computer adaptations. As of this writing, the California State Department of Rehabilitation has awarded the Community Colleges Foundation a multi-million dollar grant to establish High-Tech Centers in California community colleges based on the model developed at Monterey Peninsula College. Presently, there are 58 High-Tech Centers funded through this cooperative undertaking located at colleges and universities across the state. I.14 This year, more than 5000 disabled students will participate in the program, making it the largest project ever undertaken to provide disabled students in postsecondary education with full access to microcomputers. Representatives from colleges and universities across the country have visited the High-Tech Center and left to establish centers of their own. We are currently working with major computer manufacturing corporations on a plan to create a continuum of adaptations which function identically on mainframe, mini and microcomputers. The future of computer access for disabled individuals is truly extraordinary. This book will show you how to become a part of that future right now!

Access Requirements for Persons with Visual Disabilities

About Adaptations for Low Vision

The problem is easily defined: the 80 character wide by 25 line deep text display on the normal computer screen is far too small to be read easily by individuals with limited vision. The obvious answer is to make the text larger.

Traditional solutions to this problem have included oversized computer display monitors, use of closed circuit television systems (CCTVs), which produce a large print version of the computer screen on a separate monitor, and systems which bypass the computer display entirely and produce an adjustable, large print image on a separate device. None of these solutions have proven to be particularly effective, since all employ rather large and cumbersome pieces of equipment external to the computer itself and tend to be expensive and/or complex to use and maintain.

Although the obvious solution to the computer access needs of low vision students is readily apparent, there are a number of additional considerations which, although less obvious, are of equal importance. An ideal low vision system should provide the following capabilities:

- **It should produce a range of text magnifications.**

  Some individuals with low vision may require very little additional magnification to work effectively with the computer display; others may require greater magnification. It is not uncommon for some persons with low vision to experience fluctuations in vision requiring frequent readjustments in text display size. Each of these requirements must be addressed by the low vision adaptation.

- **It should work with both text and graphics.**

  To work effectively with information displayed on the computer screen, the large print adaptation must be capable of magnifying both text and graphics. As the trend in the computer industry is to develop ever more sophisticated combinations of high resolution graphics and text displays, this is a vital capability.

- **It should work with a monochrome, color or enhanced color display.**

  The display monitors attached to computer systems come in a variety of configurations. Monochrome displays (typically in green or amber) are most often used for text intensive applications like word processing, database management or accounting. Color or enhanced color displays are most often used with applications which combine text and graphics such as spreadsheets, statistical analysis or computer assisted design (CAD). Large print adaptations must function smoothly and interchangeably within each of these display environments and should preserve the colors of the original screen in magnified form.

- **It should be software based.**

  Low vision adaptations, in order to function unobtrusively in the educational or job setting, should be entirely software based or, at the very least, entirely self contained within the computer. Software based low vision adaptations are easily transportable from computer to computer and require no changes to existing computer systems or applications.

- **It should be cost effective.**

  In addition to the intrusive nature of conventional CCTV and large display monitors for low vision computer users, the cost of conventional large

use j

print systems has been a major factor in the limited computer access provided low vision students on many campuses. A typical CCTV system for one computer costs around $3000.00. Purchase of sufficient numbers of CCTVs to meet the computer access needs of low vision students at most colleges is neither practical or affordable. More importantly, low vision students almost always require personal ownership of a PC and large print system to function effectively in post-secondary education. If the computer and large print adaptation must be purchased with personal funds, the $5000 to $6000 price tag of such a system is entirely beyond the means of most low vision students. To be practical, low vision adaptations must be affordable. Cost reductions of 50% to 90% are possible when such adaptations are based in software or employ internal hardware to produce large print displays. 1.4

- **It should be easy to use and maintain.**

The adaptation must provide the user with a simple, easy to use method for enlarging and displaying text on the computer screen. Complex systems which require extensive training and maintenance are impractical in post-secondary education and most business settings. Instructional staff do not have the time to acquire and pass on mastery, the technical expertise to fully utilize such systems or the budget to maintain them when they need repair. An effective low vision system should be functionally available to a student following thirty minutes of instruction.

- **It should work with commercially available software.**

It is absolutely essential that low vision adaptations work with all commercially available software, including telecommunications software. This means that the adaptation must function as a "background task," providing onscreen text magnification and manipulation without interfering with the normal operation of standard word processing, spreadsheet or other software. Specialized "large print" word processors developed specifically for low vision use, for example, represent a very limited solution to computer access for low vision students.

- **It should not eliminate the system's ability to produce a normal 80 character wide by 25 line deep display if needed.**

Frequently, when working with normally sighted colleagues or instructors, it is most useful for low vision adaptations to provide an option which returns the display temporarily to a standard 80 character wide by 25 line deep display.

- **It should produce a smooth, fast display of enlarged text or graphics.**

The method in which enlarged text is displayed on the screen is most important. When the viewing area is being rapidly moved from one location to another, text should be displayed quickly and smoothly rather than in erratic jerks. As the user enters text, the display should track smoothly and continuously with the cursor. Enlarged print fonts should be clearly formed on the screen. Erratic and "jerky" text displays result in visual disorientation and slower computer use for many low vision users.

- **It should provide for automatic, adjustable scrolling of text.**

Low vision adaptations must provide for automatic text scrolling at adjustable rates of speed in either horizontal or vertical directions. Since an enlarged viewing window can present only a small amount of the actual text displayed on an 80 character wide by 25 line deep screen, this is an important feature in the normal process of editing and reviewing text.

- **It should allow movement of the magnified viewing window to any location on the screen.**

  The system must allow the viewing window to be moved anywhere on the display screen. Important information can be stored in a variety of locations on the computer screen. The adaptation must allow the user full access to the whole screen at all times. When the user resumes data entry, the system must automatically return to the cursor location.

1.6 Several outstanding low vision systems exist for both PC and Apple Macintosh computers which meet most if not all of these requirements. As of this writing, however, there are no large print systems meeting these criteria available for the Apple II series computers. The lack of adequate large print systems for these machines is due primarily to design constraints within the computer itself. The Apple II series computers represented the best and most reliable of early microcomputers to receive wide public acceptance. However, by today's microcomputer standards, these machines are severely limited. Given the fundamental design constraints of these early microcomputers (lack of memory, slow processing speed, limited access to screen memory), it is unlikely that sophisticated large print systems can be developed for Apple II series computers.

For Apple II series computers, computer terminals used by mini and mainframe systems and the majority of other non-PC microcomputers (i.e., Atari, Commodore, Radio Shack, etc.), closed circuit television systems (CCTVs) or large display monitors remain the only available avenues for providing access to low vision users.

A possible exception exists with regard to mini and mainframe computer systems. Most mini and mainframe systems make provision for a process known as terminal emulation. In this mode, PC type computers can be configured to behave like the kind of computer terminal the mini or mainframe computer normally uses. This transformation is usually accomplished through a software program or hardware device. In most instances, the adaptation which produces large print display on the PC or Macintosh is unaffected by the program or device which allows terminal emulation for the mini or mainframe computer. As long as the PC or Macintosh continues to employ its own operating system while in terminal emulation mode, large print systems should remain unaffected and allow access to normal mini or mainframe functions. Likewise, PC or Macintosh computers functioning within a network system should continue to support low vision adaptations.

About Training People to Use Low Vision Adaptations

By Jackie Wheeler
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There are a variety of adaptations for people with low vision who wish to use a computer; most are relatively simple and straightforward to use. As with any training, it is important first to assess the individual's needs, abilities and prior knowledge before planning a training program.

Considerations for Teaching Students with Low Vision

The physical environment of the classroom, especially lighting, can be quite important to the success of the visually disabled student's use of the adaptive program. Excessively bright or dim lighting as well as lighting which produces glare on the computer screen can exacerbate the visual difficulties experienced by the student. Support material should always be available in an accessible format, in large print, on tape or in text files which can be enlarged and read on the screen. Information should be presented in manageable chunks appropriate to the student's learning ability. The instructor should also be aware that the student's learning style may have been affected by his or her visual disability. It is also important to recognize that slow visual processing skills do not necessarily mean slow cognitive skills.

1.8

Prerequisites

All students should be touch typists prior to starting the program.

Training Plan

The training plan should take into consideration the status of the person's vision: visual acuity and the stability of their vision—does it fluctuate, is it better at certain times during the day than at others? Is there a need for a speech output system along with the low vision aids? Will the student need support material in large print or on tape?

The instructor should also determine the student's prior knowledge of computers, word processing in general, knowledge of specific software programs, as well as the student's attitudes and perceptions of "computers" and what they can be used for. With this knowledge, the instructor will be able to approach the basics of teaching the low vision access adaptation in a manner appropriate to the knowledge and expectations of the student.

Where to Start

Begin by giving the low vision individual an overview of the adaptation to be used. Have the low vision adaptation set up and ready to go with interesting or at least familiar text on the screen. Operate the system controls and set the print size for the person's reading needs.

With the magnification set to a comfortable size, give an overview of how the system works and what a person can do with it. Discuss a few how-to's but keep the overview simple and friendly.

Hands-On Early Success

After seeing the initial demonstration, the student should navigate around the screen in order to get the "feel" of the navigation mechanism, whether it is a mouse, joy-stick or the computer's cursor direction keys. The student should be given assurance that they cannot make any mistakes doing this or "ruin" what is

on the screen. Have the student move the viewing window around the screen and possibly input information. Keep this first exposure to the low vision adaptation simple and direct with an eye towards providing the student with a solid experience of success.

Teaching the System

When the student is comfortable with the basic concept of the system and the mechanics of navigating the viewing window, it is then time to move on to the aspects of adjusting and using the adaptation.

Size Adjustment. Teach the student to set and adjust the print size. Practice time should be given with all aspects of the device, but it is most important that the student become proficient at quickly and accurately setting print size for his or her personal needs. If the adaptation or computer program to be used allows for selection of background and text colors, this is also a good time to teach students how to select colors which provide optimum viewing.

Overview. Next, teach the student how to use the "overview" window to locate their viewing window within the overall screen. This is normally a very simple but most important operation, especially if the student is lost on a blank area of the screen.

Scrolling. Next, the student should learn how to scroll the text on the screen. All aspects of scrolling should be covered—starting, pausing, exiting the scroll mode, adjustment of scroll rate, and scanning or quick movement up or down the screen while scrolling.

Other Commands. The student should learn about the other commands such as cursor tracking, single line display, and how to change the cursor position relative to the window of information.

Practice. Hands-on practice is the key to success. The student should use the adaptation as often as possible while learning or using the PC and associated software. At this point, it is also important for the student to begin practicing periodic scanning for new information on the computer screen which may appear periodically as a result of information being generated by the program in use.

Loading and Set Up Procedures. Although initial set-up of the low vision adaptation should be handled by the instructor, once the student has become familiar with the basics of the operating system, he or
1.12 she should be taught the fundamentals of loading and setting up the low vision adaptation.

Troubleshooting. Troubleshooting potential problems at all levels of using the program should be part of the training. Demonstrate what could go wrong and how to solve the problem. Let mistakes be opportunities for learning.

About Adaptations for Blind Computer Users

Sighted individuals use a variety of techniques in viewing and producing text on the computer screen. The eye jumps from place to place. A quick glance takes the reader to an interesting sentence or a typing error.

Reading speeds up for lengthy documents, slows down for critical letter by letter, word by word analysis. The eye travels down a column of figures to check a total, glances at a program menu, examines a systems prompt or selection option. In order to make computers accessible to blind individuals, adapted computer technology must provide a nonvisual method for "seeing" the screen. This can be accomplished in two ways: the screen display can be made available in an auditory mode using advanced screen reading software and sophisticated speech synthesizers or in a tactile mode using a refreshable braille display which echoes the screen display. Because not all blind individuals read braille and because braille computer displays tend to be expensive and difficult to learn, the High-Tech Center elected to develop computer access for the blind using advanced screen reading software and speech synthesizers. These systems would enables the blind computer user to "see" the screen by employing the same scanning techniques used by sighted computer users—whether writing a document with a word processor, entering numbers in a spreadsheet, retrieving data from a database or performing a host of other commonly used computer applications.

Auditory screen reading systems are composed of two parts: the screen reading program and the speech synthesizer. Screen reading programs are available from many sources and range in sophistication from unusably simplistic to overwhelmingly complex. The fundamental task of any screen reading system is to become the "eyes" of the blind computer user. Once loaded into the computer's memory, such programs work in conjunction with whatever applications (word processing, spreadsheets, accounting systems, etc.) are in use. Screen readers provide their users with elegant and sophisticated ways to examine the content of the computer screen using all of the visual scanning techniques employed by sighted computer users. What is "seen" on the screen is sent to the speech synthesizer. The speech synthesizer is a hardware device containing sophisticated systems for translating computer code into spoken English. Like screen reading systems, speech synthesizers are available from many sources and range in speech output quality from barely understandable robotic utterances to well modulated voices with all the inflection, nuance and color of normal human speech.

Beyond the relatively simple process of providing systems capable of translating screen displays into spoken English, there are a number of considerations which must be taken into account if such adaptations are to function as genuinely effective tools for a blind computer user:

1.14 Personal Considerations

- **The blind individual must be a competent touch typist.**

  It is vitally important that the blind individual seeking access to the computer be a competent touch typist. Typing proficiency should be acquired prior to the process of learning to use a screen reading system, not during. For most individuals, the frustrations caused by typing errors during the learning process will be insurmountable.

- **What will the individual be doing with the computer?**

  Most surveys indicate that word processing accounts for the majority of work done by microcomputers. If word processing is to be the primary goal of the blind computer user, less sophisticated and therefore easier to learn screen reading programs may be a better choice. If spreadsheets, programming tasks, accounting systems or database management applications will be required in addition to word processing, a more sophisticated screen reading program is called for.

- **How well does the individual hear?**

Although it may initially seem like an odd consideration, how well the blind computer user hears and understands the speech synthesizer is inextricably bound to how well the user understands what is displayed on the computer screen. In cases where the blind computer user has normal hearing, synthesizer choice is often a matter of personal preference. Some users actually prefer the more robotic voice output of low cost synthesizers to the more natural speech of costly speech output devices. Quality of speech output becomes a more critical issue when dealing with hearing impaired and some older adult blind computer users. Under these circumstances, the flexibility and quality of speech output available with more sophisticated speech systems are vital for effective computer access.

System Considerations

- **It should provide a continuous review mode.**

The majority of screen reading systems operate in two modes: review and application. Full scale screen reading is normally carried out only in the review mode. In this mode, the user can employ all the screen reader's capabilities but cannot access the capabilities of the applications program. For example, if a word processor were in use, upon entering the review mode the document displayed on screen by the word processor could be read but not edited. In the applications mode, the word processor would function normally, but only a limited selection of screen reading options would be available. As of this writing, screen readers which provide excellent review capability while in the applications mode (a feature essential for extensive word processing) lack the sophisticated screen reading capabilities required for spreadsheets, programming and other applications which employ complex screen formats. Screen readers with sophisticated capability in review mode currently have little screen reading capacity in the application mode.

- **It should work with and not impinge upon the operation of standard commercial software.**

1.16 Some screen reading systems take over function keys commonly used by many popular computer programs (WordPerfect, dBASE, Lotus, etc.). The screen reader should provide methods for reassigning its own function keys in the event that they conflict with another computer program's function key selection. In addition, the screen reader should function concurrently and harmoniously with commercially available applications software.

- **It should be easy to use.**

As a class of computer adaptations, screen readers have the dubious distinction of being the most time consuming and difficult to learn. However, once the system has been installed and configured to work with the computer and speech synthesizer at hand, no more than one hour should be required for the user to learn the basic commands for reading letters, words and lines. To achieve competency with even relatively uncomplicated screen readers typically requires two to four weeks of continuous practice. Screen readers designed to deal with complex screen environments might require eight to ten weeks of practice to acquire mastery.

- **It should work with, and support the capabilities of, a variety of speech synthesizers.**

  Many advanced speech synthesizers provide a wealth of features designed to improve audio perception, promote faster processing of information, enhance the quality of speech output and reduce listener fatigue. Screen readers should take full advantage of every feature offered by a particular speech synthesizer. The ability of a speech output device to employ a variety of different voices, incorporate the inflection, tone and color of natural speech and produce intelligible speech at a high rate of speed are valuable assets which should not be wasted.

- **It should read letters, words or lines forwards or backwards.**

  Screen readers must be able to emulate every action in the visually oriented reading process. This includes reading single letters in order to identify possible spelling errors, words in order to orient within a line of text and lines of text in order to understand the content of the screen.

- **It should provide spoken output for the military version of all letters—i.e., a Alpha, b Bravo, c Charlie, etc.**

  In order to remove the confusing similarities in the articulation of certain letters (notably b and v, p and b) common with many low cost speech synthesizers, the screen reader should provide an alternative method for pronouncing single letters using the military transmission equivalents (A becomes Alpha, B becomes Bravo, P becomes Papa, etc.). This simple addition can be enormously beneficial when high levels of accuracy are required.

- **It should read complete sentences and screens.**

Just as sighted computer users scan written documents to obtain a sense of overall continuity and flow, screen readers must provide blind computer users with options which allow these same processes to occur in an auditory mode. A well constructed screen reading environment will be able to read a complete sentence as opposed to a single screen line of text. It will provide the option of reading full screens or complete documents. In any of these modes, the screen reader should take full advantage of all options available to the speech synthesizer which assist in the production of natural sounding speech. *1.18*

- **It should provide optional spoken output of spaces and punctuation marks.**

When reading sentences, lines, screens or whole documents, many screen reading systems and speech synthesizers use punctuation marks as cues in the production of speech. In this mode, punctuation marks are used to create the pauses and rising or falling inflections which produce natural sounding speech. However, screen readers must also supply a means of pronouncing punctuation

marks literally in order to verify their correct use and location within the text of a document.

- **It should provide optional spoken output of prompts and messages automatically displayed by the computer system or program in use.**

Many computer programs, particularly programs which provide remote access to other computer systems over a modem, often display messages and prompts of interest to the user regarding elapsed time, system charges, waiting messages, additional information waiting to be displayed or any one of a variety of other messages. Screen readers must be capable of monitoring screen locations where messages appear and of automatically reading any information appearing in those locations.

1.20

- **It should provide a method for identifying attributes of text displayed on the screen: bold, underlined, inverse or color.**

Computer programs use a variety of methods for attracting the user's attention to some important piece of information. Screen readers must provide a method for identifying and describing the display attributes of text.

- **It should provide windows: user defined screen locations which can be instantaneously accessed.**

The great majority of computer programs include screen designs which incorporate menu selection areas, help screens, or information display areas or, in the case of spread sheets, columns of numbers which must be read vertically. The solution to reading these specialized screen areas involves the creation of user defined viewing areas called windows. Screen readers must provide a simple and easy to use technique for locating the screen area for which a window is to be defined, defining such areas and returning to them at will.

- **It should support fast, accurate cursor routing.**

Frequently, when text is being examined in the review mode, the user will discover a problem area or location where he/she would like to resume editing upon exiting the review mode. In order to make that possible, screen readers must support a function know as cursor routing. When cursor routing is in use, upon exiting the review mode, the applications cursor is automatically redirected to the previous screen location of the review cursor.

- **It should support a well defined macro capability.**

The secret to creating screen reading environments which provide excellent screen reading capability while seeming to remain constantly in the applications mode rests with the program's ability to create and use macros. A macro is nothing more than a set of instructions to the screen reader which can be stored in a unique keystroke. A typical macro command designed to read one word to the right might include the following instructions: enter the review mode, read one word to the right, exit the review mode, issue the word processing command to advance the cursor one word to the right. If the screen reader is fast enough and the macro facility well designed, all of this will appear to happen without ever leaving the application. Well designed macros can allow a screen reading environment to be designed in such a way that it appears to merge with the program whose screens it is reading.

- **It should work with terminal emulation programs.**

  Because most terminals used by mini and mainframe computer systems do not support screen reading software, the only available access to such systems for blind computer users may be through a process called terminal emulation. In this mode, PC type computers can be configured to behave like the kind of computer terminal the mini or mainframe computer normally uses. This transformation is usually accomplished through a software program or hardware device. In many 1.22 instances, the screen reading system is unaffected by the program or device which allows terminal emulation for the mini or mainframe computer. As long as the PC continues to employ its own operating system while in terminal emulation mode, the screen reader should remain unaffected and allow access to normal mini or mainframe functions. Likewise, PCs functioning within a network computer system should continue to support screen reading adaptations.

For blind computer users who read braille, a number of printers exist which, when used with specialized software, produce high quality, grade two braille at a maximum of 80 characters per line. Reproduction of brailled graphics, as of this writing, remains experimental with no fixed standards yet established.

Excellent screen reading systems exist for IBM

PS/2, IBM PC, 100% PC compatible, Apple II, and Macintosh series computers.

About Training Blind Individuals to Use Computers

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The wide variety of screen reading systems and speech output devices for computers present a variety of interesting challenges when planning a training program for blind individuals. Programs vary in simplicity—which sometimes means "easy-to-use" and sometimes indicates a very limited program. Some programs, although very sophisticated, are not difficult to use and can be individualized to fit the student's needs. The quality of speech output devices varies from easy-to-understand to output that requires real concentration for accurate comprehension. The wide range of synthesizers and screen reading programs can be mixed and matched to meet the specific needs of the blind individual. The goals, abilities and requirements of the student should be carefully considered in the course of planning a training program.

It is most important that you, as the instructor, understand and feel comfortable with the screen reading program. Most likely, you will choose one screen reading program to be used at your center. Practice with the screen reading system and the software with which you will be using it until you are quite familiar with its use.

In working with blind students who have no previous computer experience, it is almost always best to begin by teaching the student to use a word processing program in conjunction with the screen reading system. In this way, the student gains access to a valuable and useful tool with immediate practical application in his or her day-to-day activities. Instruction in the use of the word processing system should be conducted in a step-by-step manner with special attention to ways of locating text and correcting errors.

When you are ready to work with a student, begin by evaluating his or her needs, abilities, and prior computer knowledge. If the student has enough vision to read large print on the screen, you may well wish to teach the use of a large print adaptation along with the screen reading system.

Exciting things happen when teaching people how to access a computer, especially when they start to understand the limitless options now available when using this new tool. Although teaching people to use computers may be new for you, remember that the computer is just a tool and your basic teaching skills and abilities are the important parts of the total training equation. Relax and have fun.

Considerations for Teaching Students Who Are Blind

Many aspects of the classroom environment are important when working with blind students. The classroom needs to be physically accessible, and the placement of furniture and equipment should remain as consistent as possible. The noise level should be kept low, and, unless the teaching is one-to-one in an isolated setting, students should always use headsets with the speech output devices.

Support materials should be available in braille, large print, and/or on tape. Disks and other equipment should be marked in braille and/or large print as needed. It is possible to make tactile replicas of screens which can be valuable in conveying to the blind student a sense of physical screen layout. It is also possible to emboss (with a braille printer) screens of text. This can give the student added information and reference material. The students need to know where support and reference materials are located for easy, independent access. The student's individual materials should be marked and located at or near their work station.

Although many people who are blind are quite familiar with a typewriter keyboard, a computer keyboard may be a new experience. Additional special keys (Esc, Alt, Ctrl, Home, etc.) exist on the personal computer keyboard and there are no fixed standards as to where such keys are located. Some keyboards are much easier to learn and use than others. To assist blind individuals with locating these nonstandard keys, such keys can be tactilely marked in a variety of texturally distinct ways: Velcro or felt dots, transparent braille labels, or dots of glue can all be successfully used. On the main alphanumeric keyboard, keys that are helpful to mark include the Shift, F, J, 4, 7 and 5 on the cursor/number pad. Special keys to mark include Ctrl, Alt, Esc, Return or Enter, Backspace, Insert and Delete.

Mobility skills and concepts often are a factor in teaching a totally blind student. The instructor should be aware of access to and from the classroom as well as mobility issues within the classroom itself. Mobility concepts bear a strong relationship to general spatial concepts. Blind students who experience difficulty with mobility and spatial concepts may also experience difficulty with page formatting concepts as well. Such students will require additional time and may benefit

from tactile representations of the computer screen or hard-copy braille information.

The individual student's learning style may be affected by a wide variety of factors. These can include, but are not limited to, degree of vision loss, cause of blindness, the length of time the person has been blind or had low vision, vision fluctuation and past educational experiences. The amount of information presented at any one time should be carefully matched to the student's learning capabilities. Again, be aware of the fact that learning styles and educational experiences may have been influenced by visual difficulties.

Prerequisites

All students should be touch typists prior to starting the course.

Training Plan Information

Along with information about the student's visual status, you will need to determine the status of the student's "computer knowledge." This should include the extent of prior knowledge or experience with computers, word processing in general, and other software programs as well as the student's attitudes and perceptions about computers—their uses and their limitations.

Training Plan

Plan for early success. A successful experience with the access device within the first thirty minutes will help assure future successful sessions. It is best to separate the material for each individual student into manageable blocks of information. Try not to overwhelm the student with too much information at one time, especially with computer jargon and unfamiliar acronyms (unless this is what they can relate to). It is important to provide time for independent practice, making sure that support materials and help are always available.

Take into account information about the student's background, interests, capabilities, and needs when producing a plan. Remember to be flexible—people learn to use computers in a variety of ways that can change and "take-off" at any time. Sometimes a student can be highly motivated because of a specific software program.

Where to Start

1.28 The first step is to give an overview of the screen reading program. Make it general but touch on aspects and commands that will be important for the student's needs. Use material that is fun and interesting and possibly familiar to the student. Set up the screen reading program in the computer along with the software you will be teaching. Set the appropriate speed, pitch, and volume for the synthesizer in your environment. At first, use the screen reading system to read what is on the screen and simply have the student listen to the text. Give a basic "tour" of what the screen reading program is all about.

Discuss a few how-to's and give an orientation to the personal computer keyboard and the most frequently used commands. Give the student quick reference material in braille or large print as support. Keep this a short orientation on the basics—simple and friendly.

Hands-On Early Success

Reading. After the overview "tour," turn the keyboard over to the student. Let the student practice reading the familiar text that you previewed with a few of the basic up/down and right/left screen reading commands. Basic instruction should include reading lines, words and characters, and, if your screen reader uses one, learning how to go into and out of a review mode. Let the students have time to navigate around the screen and read independently. Assure the students that they cannot damage the computer, screen reading system or speech output device.

Writing. Have the student create a short paragraph of text. Once the screen reading system has been understood, many students enjoy creating their own text. Other students may feel threatened or insecure about using a new tool, or, perhaps, simply can't create on the spot. It's a good idea to have something ready to dictate, or you may simply ask the student to write some familiar text such as a poem, song, or nursery rhyme.

With a familiar paragraph to read, the student should now practice reading their own text. During this writing, the student should not be concerned with typing errors. The focus of the exercise should be simply writing and reading. When this exercise has been successfully completed, introduce the student to reading for error identification and using the backspace erase function of the word processor to correct discovered errors.

More Screen Reading Commands

When the student is familiar with the basic line, word and character navigation commands, it is time to move on. The number of other commands that you teach during one lesson will depend on the student's progress. Make sure you give the student adequate, independent practice time.

It is time to teach

- **Help commands**
- **Quick access of the top and bottom of screen**
- **How to access a specific line of text**
- **How to hear what is to the right or left of the cursor on a line**
- **How to hear the screen coordinates for the writing cursor and the reading cursor**
- **How to go into and out of a review mode**
- **How to set and find placemarkers**
- *1.30* **Reading within columns; setting and storing column marks**
- **If in a review mode, how to put the writing cursor at the point of the review cursor and exit the review mode. This is called routing in some programs.**

Setting and Changing Options

Most programs give the user great flexibility in the way the text is spoken. This is quite important because at times it is important to hear everything that is on the screen; spoken punctuation marks and spaces, for example. At other times, it is best just to hear straight text. The number and types of options vary between programs. Review the options available in the program you are using and determine those best suited for the individual student's needs. Give the student an overview of the options. Discuss when and where certain options might be useful.

Show the student how to learn the current options settings and then how to change and store option settings.

Some basic options settings to teach might include

- **Letters spoken as typed**
- **Numbers as single digits or as words**
- **Punctuation marks, spoken or not**
- **Spaces between words, spoken or not**
- **Text colors, spoken or not**
- **Text attributes (bold, underlined, etc.), spoken or not**

Have the student work independently with one combination of options, then change one setting at a time. This will allow the student to determine which options work best with what programs.

Start Up

Start up procedures can be taught throughout the course of instruction. It's best not to have the student worry too much about specifics initially. At first, the student simply needs to understand how to start the screen reading program. It is, however, very important for the student to know the entire set up procedure by the end of the training program.

Troubleshooting

Throughout the training, it is good to either give examples of problems that could arise or use mistakes as opportunities for lessons on potential difficulties and how to solve them. Periodically, present problems for the student to solve. Problems will occur spontaneously during the course of the training. Discuss with the student the nature of the problem, when and how it occurred and how the problem can be solved. In order to function effectively when working independently, the student must be aware of as many problem situations and their solutions as possible.

Independent Practice

It is critical for the student to work independently on each area of the screen reading program. Integration of the screen reading system along with instruction in the use of other software (typically, word processing) should be carried out concurrently. Along the way, give simple reviews so you and the student can measure progress. Reviews can range from a few how-to questions to writing documents free from typographical errors.

Enjoy with your student the excitement of learning to capture some of the power of a personal computer.

Access Requirements for Persons with Mild to Moderate Orthopedic Disabilities

About Adaptations for Computer Users with Mild to Moderate Orthopedic Disabilities

Orthopedic disabilities can result from many causes: accident, stroke, birth defects, viral infections and neurological disorders, to name a few. Individuals with orthopedic disabilities make up the largest segment of the disabled population. For persons with orthopedic disabilities which affect the upper body, productive use of computers must address three critical issues: keyboard positioning, keyboard access and typing speed.

The range and scope of mobility impairment resulting from such disabilities is enormously varied. It can be as relatively trivial as reduced dexterity in the finger of one hand as a consequence of injury or as dramatic as complete loss of all gross and fine motor control as in a case of cerebral palsy. To provide a structure for evaluating the computer access requirements for orthopedically disabled persons, we have established a working range of disability extending from mild to severe. Within the context of providing appropriately adapted computer technology, the following definitions are applied:

- **Mildly orthopedically disabled persons do not require repositioning of the keyboard or computer, are typically one-handed typists and can accurately access all keys on the keyboard using one or more fingers.**
- **Moderately orthopedically disabled persons typically require repositioning of the keyboard and/or screen, and can accurately access all keys on the standard computer keyboard using a hand held touch stick, head or mouth stick, toes or other body extremity.**

- **Severely orthopedically disabled persons cannot access the standard computer keyboard and require an alternative input device (i.e., scanning system with single switch, communicator boards, voice entry, optical selection, etc.).**

There are three important factors which must be considered when determining the computer access needs of persons with orthopedic disabilities in post-secondary education: keyboard positioning, adaptations to provide keyboard access and adaptations to enhance typing speed.

Keyboard Positioning

2.2

Correct keyboard positioning will allow persons with moderate levels of orthopedic disability to minimize physical exertion and thus reduce fatigue. Properly positioned keyboards also help to decrease the spasticity and resultant keyboarding errors which frequently occur from straining to reach portions of the keyboard. An in-depth description of procedures for determining correct keyboard positioning is provided at the end of this chapter.

Keyboard Access

Adaptations which provide keyboard access are vitally important. The multiple keystroke commands common to many computer applications can be an obstacle to persons with virtually any degree of orthopedic disability. How, for example, can a one handed typist or headstick user hold down a key on the left hand side of the keyboard while simultaneously pressing another key on the right hand side of the keyboard? Additionally, most standard computer keyboards have an automatic key repeat feature which is triggered after a key is held for more than one second. For persons with limited fine motor control, this feature frequently results in unwanted keystrokes and much time wasted in error correction. Well designed keyboard adaptations can remove all of these obstacles and greatly improve keyboard access, reduce keyboarding errors, enhance speed and diminish fatigue in orthopedically disabled computer users.

Enhancing Typing Speed

Given the sophistication and flexibility of adapted computer technology available for individuals with orthopedic disabilities, it is a relatively easy task simply to provide access to the computer. Although computer access is vitally important, it is not the complete solution. Adaptations which enhance typing speed are vitally important to disabled persons who are unable to type more than 10 to 12 words per minute. This becomes a particularly critical consideration for persons with moderate to severe orthopedic disabilities who typically type at a much slower rate. The orthopedically disabled computer user in a post-secondary educational setting must be able to produce written materials (research papers, essays, reports, etc.) in a timely manner. Adaptations exist which can significantly improve the rate at which such persons are able to produce written materials.

The Target Audience

Functional and effective adaptations presently exist which can provide excellent computer access for persons with mild to severe orthopedic disabilities. Adaptations for mild to moderately orthopedically disabled persons can be implemented easily, inexpensively and with a minimum of training. Frequently, such adaptations are capable of providing a high level of computer access for many who would previously have been considered severely physically disabled.

Adaptations for severely physically disabled persons, using our definition of the requirements necessary to provide truly functional levels of computer access, tend to be considerably more elaborate, uniquely configured systems designed to meet the highly specialized needs and abilities of a particular user. The highly specialized technologies required to meet the computer access needs of severely orthopedically disabled individuals are addressed in a separate chapter of this book.

2.4 Adaptations which allow mildly to moderately orthopedically disabled persons to access microcomputers must address the following areas.

Specialized Adaptations to Control Keyboard Functions

Some of the most useful computer adaptations available for individuals with orthopedic disabilities are programs which provide control of fundamental keyboard functions. For many disabled persons, use of such an adaptation is basically all that is required to gain computer access. Programs of this type should meet the following criteria:

- **It must be software based.**

  Such adaptations should themselves be computer programs which can be easily loaded into the computer. In this way, the disabled computer user can easily move from computer to computer without being dependent upon specialized hardware modifications attached to a single computer system.

- **It must stop the automatic key repeat function.**

The automatic key repeat function common to many computer keyboards can be a serious impediment to many physically disabled individuals. Limited fine motor control often makes the quick release of keys difficult to impossible. This is particularly true of persons who use touch sticks of various kinds to access the keyboard. Keyboard control programs must be capable of turning off the key repeat function.

- **It must "desensitize" the keyboard.**

For moderately orthopedically disabled computer users, one of the most frustrating aspects of accessing a physical keyboard is the unintentional pressing of keys. Individuals with limited fine motor control often brush unwanted keys with a protruding finger or misdirected touch stick in the processing of pressing the desired key. A great deal of time is thus spent erasing unwanted characters from the computer display. The traditional approach to solving this problem has been through the use of key guards; keyboard covers which limit access to an area directly above each key thus reducing the occurrence of accidentally pressing unwanted keys. This same result can be created by keyboard control programs which in effect tell the keys on the keyboard how long they must be held down before sending a letter to the screen. By introducing a very small delay factor, the great majority of accidental keystrokes can be eliminated without significantly reducing typing speed.

- **It must "latch" the Ctrl, Alt, Shift and/or other special purpose keys.**

Pressing several keys at the same time to issue a command can create a tremendous obstacle for one handed or touch stick computer users. Many widely used computer programs make frequent use of special keys on the keyboard such as the Ctrl and Alt keys to carry out commands. PC type computers, in fact, require the user to simultaneously hold down two keys on the left side of the computer keyboard while pressing a key on the right side of the keyboard in order to restart the computer in the event of a system "crash." The complex feats of dexterity required by many programs are difficult enough for individuals with a complete set of working fingers; without keyboard control programs, such programs are virtually inaccessible to orthopedically disabled persons. Such programs must be capable of "latching down" the Ctrl, Alt and Shift keys individually or in combination. The program should provide an automatic release feature to "unlatch" these special keys after a second, non-special, key has been pressed. This is particularly useful in the case of the Shift key which must be held down in order to type the characters on the upper half of the numbers row and other keys. 2.6

- **It must not interfere with the operation of other programs.**

In order to provide the disabled computer user with complete access to the full range of commercially available software, the keyboard control program must not interfere with the simultaneous operation of other programs.

- **It must provide a high degree of flexibility.**

Because of the great variability and range of orthopedic disability, keyboard control programs

must allow for great flexibility in the choice of which control features will be activated. Unneeded adaptations can themselves be a barrier to successful computer access. It is always best to use only those adaptations which are truly necessary.

- **It must provide a method for replacing selections made with a mouse or other pointing devices with selections from the keyboard.**

Selecting on-screen choices with a mouse, joystick or other pointing device is an exercise in fine motor control. The point and click operation which makes use of such systems easy for persons with good fine motor control may create a serious difficulty for persons with reduced fine motor control or hand/eye coordination difficulties. The system should be capable of assigning pointing and clicking control to other keys on the keyboard.

2.8

Alternative Methods for Entering Program Commands

Increasing the speed with which orthopedically disabled persons are able to enter text or carry out program commands will allow them to work faster. Generally, increases in the speed and efficiency with which orthopedically disabled persons can use computers is gained cumulatively and in small increments through careful selection of appropriate adaptations. One of the most productive areas in which gains in processing speed can be obtained is in the issuing of program commands. The complex, multi-keystroke commands used by word processing programs, spread sheets and other such programs can often be issued much more quickly through the use of alternative input devices which bypass the keyboard entirely or modify its function.

■ Touch tablets.

These tablets are external pads generally around three quarters of an inch thick and measuring approximately 8 by 10 inches on a side. Such tablets have a grid of touch sensitive locations. Each location can be programmed to carry out a particular command. When a particular location on the tablet is touched, the preprogrammed command stored at that location is sent to the computer just as if it had been typed at the keyboard. Cells on the touch sensitive grid can be labeled in ways which are meaningful to students and easily reprogrammed for use with a wide array of computer applications. Touch tablets are generally most useful for mildly orthopedically disabled persons. If they are used with moderately orthopedically disabled individuals, the user must have good control of the touch stick, and the tablet must be carefully positioned for maximum access.

■ Speech recognition.

Speech recognition systems allow program commands to be spoken. An external microphone transmits the verbal command to the speech recognition system within the computer where a complex interaction of computer hardware and computer program attempts to match the sounds of the spoken command with a list of sounds the system has been programmed to recognize and respond to. If a match is found, the commands associated with the sound are sent to the computer just as if they had been typed at the keyboard. If you think all of this sounds a little complex and error prone, you are generally correct. However, used carefully and appropriately, speech recognition systems can be extremely useful provided the following guidelines are observed:

1. The user must have completely unimpaired speech.
2. Speech recognition is only used to augment, not replace, keyboard entry.
3. The list of spoken commands to be used is restricted to 25 or 30 items, each command is multi-syllabic and auditorially distinct from all other commands. Avoid commands like “GO,” “YES,” “TOP,” etc. Use “SAVE DOCUMENT” rather than “SAVE,” and “TOP OF PAGE” rather than “TOP.”
4. The user is willing to devote many hours to “training” the system to recognize his/her voice.

Speech recognition for microcomputers is still very much in its technological infancy. Used selectively and with the appropriate individuals, it can be a powerful aid to faster text production. 2.10

- **Keyboard “macro” programs.**

“Macro” is a bit of computerese which says absolutely nothing about what macros actually do or how useful they can be to persons with orthopedic disabilities. Essentially, keyboard macro programs allow the user to redefine what a particular key or combination of keys does. Program commands can be assigned to unique key combinations and entered just as if they were typed from the keyboard. The key combination “Alt S,” for example, might be assigned a series of word processing commands which would save the document being written, load the spell check program and begin proofing the document. Whenever the user presses the Alt and S keys, this series of commands will be carried out. Keyboard macro programs are easy to use, extremely versatile and, once a set of special keys have been assigned commands, can significantly improve the speed with which orthopedically disabled persons are able to use many common computer applications.

Real Time Spell Check, Correction and Thesaurus As an Aid to Faster Text Production

Spell check and correction programs which monitor spelling and offer to automatically correct errors as a document is being written can substantially reduce the amount of time ordinarily required for such tasks. The kinds of spelling errors which sometimes occur as a result of miskeying due to limited fine motor control can be instantly corrected. Computerized thesauruses which perform automatic word replacement also enhance the text production process.

2.11

Smart Word Processors for Enhanced Typing Speed

Smart word processors employ the newly emerging technology of artificial intelligence to make accurate predictions about word choice while a sentence is actually being written. Using a predictive rule base about how the English language works, word frequency patterns and a history of the user's word choice preferences, such systems can very accurately predict the completion of a word being written based on its first two or three letters. The user is shown a list of likely choices and may elect to complete the word or phrase by pressing a single key. Such systems also automatically manage such tasks as inserting the correct number of spaces after periods and other punctuation marks and beginning each new sentence with a capital letter. Additional options allow the user to insert com-

monly used phrases, add header and signature blocks to letters or modify verb tense. The utility of such a program becomes markedly apparent when used with individuals having moderate to severe orthopedic disabilities. Perhaps more than any other single adaptation, the interventions provided by smart word processors can dramatically increase the speed of text production.

Screen Reading Systems

The same screen reading system and sophisticated speech synthesizer which allows blind computer users to hear what they cannot see can become the "voice" of orthopedically disabled individuals whose speech production is impaired. Reading aloud what we have written, hearing the flow and cadence of sentence construction, is a vital step in the process of developing well constructed prose. Using screen reading systems and sophisticated speech synthesizers, individuals with speech impairments resulting from orthopedic disability need not be restricted from this process.

A unique design feature makes the IBM PC type computer ideally suited for use with orthopedically disabled individuals. On the majority of other computer systems, when a key (for example, the A key) is pressed down on the keyboard, an electrical impulse representing the letter A is immediately generated and sent directly to the display screen. There is virtually no way to modify the process, thus making it extremely difficult to alter keyboard function so that it works more in accordance with the needs of orthopedically disabled users. The PC type computer does something quite different. Rather than sending a letter when a key is pressed, it sends a location code in effect saying "The key at this location has been pressed, what would you like to do about it?" The architecture of such a system provides ample opportunity to modify the basic functioning of the keyboard. This ability to drastically alter keyboard function using only software based adaptations makes the PC type computer specially "user friendly" to individuals with orthopedic disabilities.

The Apple Macintosh computer supports many high quality macro programs, but provides for limited keyboard modification through software selection. Good macro programs exist for the Apple II series computers although the keyboard can only be effectively modified through the use of hardware adaptations.

An excellent selection of alternative input devices exists for each of these computer systems. Speech recognition, however, is not recommended for the Apple II series.

2.14 Smart world processors are presently only available for PC type computers. However, Macintosh systems are easily capable of supporting the technology and should offer such programs in the near future. Excellent continuous, real-time, spell checkers and thesauruses are available for both Macintosh and PC type computers.

Determining Correct Keyboard Positioning for Persons with Orthopedic Disabilities

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The optimal keyboard position and adaptations for a student are those which can be used accurately and quickly and are adequate to satisfy the specific needs of the individual. For most disabled students needing access to computer keyboards, it is essential that the keyboard can be used for long periods of time with minimal physical exertion or fatigue, and that consistent performance can be obtained from day to day.

An essential prerequisite for keyboard use is a stable and comfortable seating system. If a person cannot sit comfortably in a well-balanced position, requires his arms to support body position or needs to make constant position adjustments while using the computer keyboard, the seating system should be modified. There are several commercially available and custom positioning systems or seat inserts used in a wheelchair to optimize comfort and function and minimize the development of physical deformities. An occupational or physical therapist can help determine the most appropriate system.

The following systematic approach designed to optimize an individual's use of the keyboard is derived *2.15* from Barker and Cook (1981) and Cook and Barker (1982). The process to determine optimal use of the keyboard includes the following steps:

1. **Review the user's history with keyboards and other technical aids.**
2. **Identify controllable anatomic sites (CASs).**
3. **Screen each CAS.**
4. **Match each CAS to a keyboard configuration (position and adaptations).**
5. **Comparatively evaluate the combinations identified in step 4.**

The Student's History

A student's history provides insight when making decisions during the evaluation process. This will help in determining controllable anatomic sites, appropriate positioning of the student and the keyboard, and identification of needed modifications. This information should include

- **The nature of a student's disability.**
- **The student's experience with keyboards and assistive devices.**
- **The problems and acceptable solutions encountered by the student with previous use of keyboards.**
- **The known learning disabilities.**

Identification of Controllable Anatomic Sites

2.16 To use a keyboard, the possible controllable anatomic sites (CASs) include the hands, head and feet. Specific potential anatomic sites are listed in Table 2.1. All possible CASs should be scrutinized. Not only should the student's opinion of physical ability be considered but so should all anatomic sites at which the student can demonstrate purposeful controlled movement.

The minimum requirement to use a keyboard is one isolated "pointer" that can press one key at a time. "Pointers" include a finger, a hand held dowel, a mouthstick, eye blink switch or headstick. An isolated pointer minimizes errors related to pressing or hitting keys with other parts of the body (i.e., another finger unintentionally activating a key when using the index finger as the pointer).

When a hand is used, there are several strategies that can be used to isolate a finger as a pointer and minimize errors due to key hits by other fingers. These

Table 2.1 Potential controllable anatomic sites useful with a keyboard, listed in order of potential optimal keyboard use

2 Hands, all fingers
1 Hand, all fingers
2 Hands, <5 fingers/hand
2 Hands, able to isolate 1 finger per hand*
1 Hand, <5 fingers/hand
1 Hand, 1 finger, isolated*
The head, with a mouthstick with a headwand
The feet, toes demonstrate fine motor control, 1 toe isolated*

*Isolated—no other fingers or toes demonstrate fine motor control or can be used in conjunction with a "pointer."

include (1) putting a sock or a mitt, with a hole cut out for the pointer finger, over the unused fingers that are held in a fist, (2) to have the student hold a dowel to maintain a fist with the potentially interfering fingers. A handheld dowel or a dowel secured to the hand can also be used as the pointer. There are several writing aids designed to hold a pencil which could also be used to hold a pointer. Utensil cuffs can also be used to hold a pointer. The writing aids and utensil cuffs can be acquired from distributors of aids for daily living or hospital supplies.

For someone with good head control, a headwand or a mouthstick can be used. These are commercially available or can be made. It is important that these fit well and are sturdy so that keys can be consistently and accurately pressed.

Screening for Controllable Anatomic Sites

Each CAS is evaluated for range of movement and for the degree of motor control or resolution. Range is the area in which the user can produce functional, controlled movement. Resolution is the smallest possible spacing between two points that the user can reliably and distinctly select. Screening forms used to determine range and resolution are included in the Appendix, which starts on page 2.22. The screening of CASs can result in the identification of several anatomic sites with sufficient control to use a keyboard.

Matching Controllable Anatomic Sites to Keyboard Position and Adaptations

The next step is to match the range and resolution measurements with placement and adaptations of a keyboard. Table 2.2 is used to match range and resolution to keyboard position and adaptations. For each CAS, the keyboard should be positioned in the middle of the range demonstrating fine control. For example, when using the right hand with a full range of motion,

Table 2.2 Matching range and resolution to keyboard position and adaptations

Range	Limited	Limited or typical	Typical	Typical
Resolution	Fine	Gross	Fine in limited area	Fine everywhere
Initial evaluation with hardware	Keyboard positioned in middle of range	Keyboard with adaptions and positioned in middle of range	Keyboard positioned in middle of range with fine control	Keyboard positioned in middle of range or centered about CAS

the keyboard is initially positioned to the right of the user's midline, perpendicular to the resting position of the right hand and arm and at a comfortable height for the student, usually with the elbows bent at about 90 degrees. As another example, when using the head with a headwand with a full range of motion, the keyboard is placed at midline and elevated and angled so that the user does not need to lean over to activate the keys.

Keyboard Position. The primary considerations to optimize keyboard position are table height, keyboard angle and wheelchair accessibility. People in standard wheelchairs usually sit higher than people sitting in typical chairs so that desks are usually too low to accommodate a wheelchair. The table that supports the keyboard for the wheelchair user must be high enough and have legs positioned such that they do not interfere with the wheelchair getting under the table. Blocks or bricks can be placed under the table legs to increase the table height. Tall tables such as those used for computer printers, drafting tables or adjustable height tables are commercially available. Adjustable height tables are useful when several people requiring different table heights use the same computer.

If increasing the table height for wheelchair clearance results in too high a keyboard position, standard arms on wheelchairs can be replaced by desk arms so that a lower table can be used. A wheelchair laptray can also be used to address this problem.

To angle the keyboard, wedges made of wood or hard foam (which can be carved with a knife) or a drafting table can be used. It is essential that the keyboard is secure. A ledge can help keep it in place. To keep the keyboard from sliding, use Dycem (available from distributors of hospital supplies) or non-skid carpet pad.

Keyboard Adaptations. For a potential keyboard user with limited fine control, keyboard adaptations would be used. Adaptations may make the difference between using a standard keyboard or resorting to more complex and expensive solutions. Adaptations can be in the form of hardware or software.

The time required to activate a key can be lengthened using software solutions. This time is referred to as activation time. For example, a pressed key usually sends a character to the computer immediately. If the activation time is lengthened, the user must hold the key down for the duration of the activation time in order for a character to be sent. This strategy can help improve a person's accuracy if a person is hitting keys unintentionally while reaching for the desired key.

If accuracy is not improved by lengthening activation time, a keyguard can be used. Keyguards help prevent accidental activations, help isolate and line up
2.20 the pointer with the intended key (particularly useful with a headwand) and can provide support for the hand. Hand support can also be provided with a ledge positions or a buildup in front of the keyboard to provide support at the wrist.

Hardware or software modifications can be used to disable the automatic repeat feature. This is useful if the user tends to hold a key down for an extended period after the initial activation.

Comparative Evaluation

Following the initial screening, several combinations of controllable anatomic sites, keyboard positions and adaptations are identified. One optimal combination is determined using a performance evaluation to compare the combinations against each other. To evaluate the use of these combinations, functional performance of each combination is measured (see Appendix). The evaluation measures include speed and accuracy when using the keyboard, the degree to which the use of a combination causes fatigue, and the degree to which the performance with a combination can be repeated over time, e.g., from week to week. Other considerations for adequate performance are the time necessary to develop the skill and the user's satisfaction. Performance should be satisfying and should be such that tasks are done with the greatest possible accuracy within the shortest period of time.

Speed is measured during a task by using the combination of CAS, position and adaptation. Speed is broken into two components, track time and select time. Track time is the time required to move the anatomic site (hand, head with headstick, foot, etc.) to the keyboard. It is measured by recording the time it takes to activate the keyboard from a resting position. Select time is the time required to move between keys once the anatomic site is positioned at the keyboard. It is measured by recording the time required to activate several predetermined keys and subtracting the track time.

Accuracy is measured by evaluating the number and pattern of errors. The error pattern reflects whether keys adjacent to or far away from the target key are unintentionally activated.

Speed and accuracy are measured using either a marked keyboard test or a typing test (see Appendix).

For most keyboard applications, optimal use of the keyboard is dependent on its continual use. Consistent use of a keyboard depends on the degree to which it causes fatigue. Fatigue is related to the comparisons of measures for speed and accuracy taken at the beginning and at the end of a session. The amount of effort required to use the keyboard should also be subjectively evaluated, and the students opinion should be solicited as well. The student's opinion will have a great deal to do with the likelihood of successful use of a keyboard on a day-to-day basis.

Repeatability is used to measure the degree to which performance is maintained over time. The measures of speed, accuracy and fatigue are compared between sessions. A lack of repeatability can be due to many factors including inconsistent positioning of the keyboard or of the user's seating position.

Summary

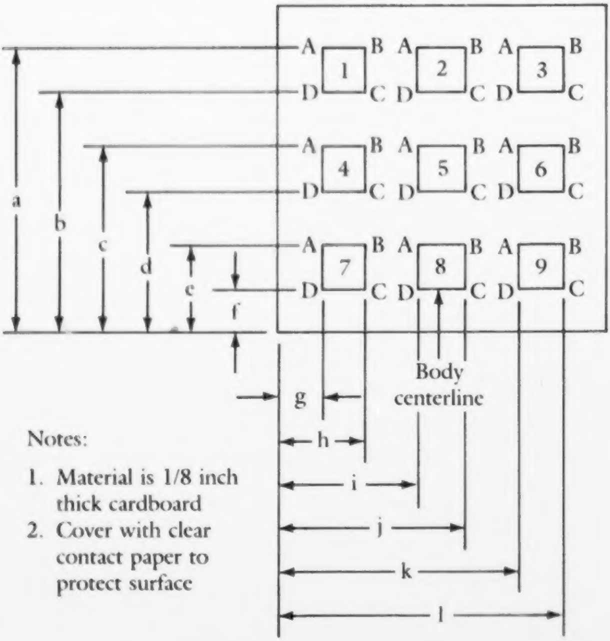
The outcome of these tests, which are performed for each of the combinations of CAS and keyboard position and adaptation, is a rank-ordered list of the combinations which are deemed to be potentially useful to the specific student. The rank order should be based on the comparative evaluation as well as the degree of satisfaction expressed by the student. The position of the keyboard and the equipment used during the evaluation to position and adapt the keyboard should be carefully documented for ease of replication. 2.22 A photograph of each configuration is useful.

This evaluation method will identify an optimal method of keyboard for a particular student. If the identified method is not satisfactory to the student or a method to use the keyboard cannot be identified, other computer access methods should be explored.

The identification of a method to access the keyboard is only part of the total evaluation regarding the use and application of computers. Cognitive, language and perceptual abilities also must be considered to insure success.

Appendix

Range and Resolution. Arm range within the workspace is determined using a sheet of cardboard with 9 drawn rectangles (Figure 2.1). The client is



Notes:

1. Material is 1/8 inch thick cardboard
2. Cover with clear contact paper to protect surface

	Hand	*Foot/child*
a	18.0 inches	15.0 inches
b	15.0	13.5
c	12.0	10.0
d	9.0	8.5
e	6.0	5.0
f	3.0	3.5
g	3.0	3.5
h	6.25	5.0
i	12.25	10.25
j	15.5	11.75
k	21.5	17.0
l	24.25	18.5

Figure 2.1 Plan of testing sheet used for range measurement of hand and foot. The foot sheet is also used with small children with limited reach. (Cook and Barker, 1982.)

asked to touch each of the corners of each of the rectangles on the range sheet. An estimate of resolution can be determined by observing how closely the client is able to touch each of the corners. Data recorded includes furthest reach, closest reach, maximum left and right reach and the resolution in each of these areas (Table 2.3). Range is described as large or small, and resolution is described as being fine or gross in order to determine keyboard placement and adaptations. For keyboards, if the range is less than one square foot, the range is considered small. The numbers together with a subjective determination of the difficulty of the task for the client's usable workspace (range) and the degree of motor control in that range (resolution).

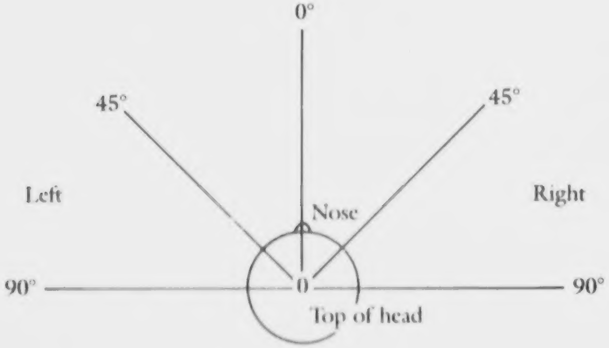
To evaluate the head, the range is measured using a protractor that is placed under the chin or beside the head, and the number of degrees of neck rotation and flexion are recorded (Figure 2.2). If the full excursion 2.24 of the head from left to right is less than 30 degrees, or up to down is less than 15 degrees, the range is considered small.

Quantitative Evaluation. To measure speed and accuracy, use the marked keyboard test or a typing test. A typing test is used only with users that are (1) familiar with the keyboard (do not need to look at the keyboard to find selections) and (2) using more than one "pointer" (i.e., single finger, headwand, mouthstick). A typing test consists of timing and recording errors while a given set of sentences is copied. The marked test is used by those who are not familiar with the keyboard or are using one pointer. The marked keyboard test requires that the user look at the keyboard. Several keys are labeled in a similar manner, for example with 1/2 inch diameter dots of the same color. Timing and recording errors are done while the keys

Table 2.3 Controllable anatomic site screening for hands and feet

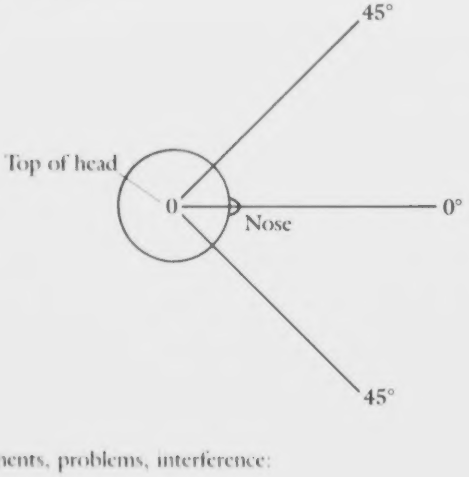
CAS	1	2	3
Description			
Range—measure in inches			
Furthest reach			
Closest reach			
Max left			
Max right			
Resolution—record fine or gross			
Far			
Close			
Left			
Right			
Comments/ interference/ problems			

Indicate maximum head rotation to the left and right and note resolution to the left and right (gross or fine):


0°
45°
45°
Left
Right
Nose
90°
0
90°
Top of head

Indicate head flexion and extension and note resolution in flexion and extension:

2.26


45°
Top of head
0
Nose
0°
45°

Comments, problems, interference:

Figure 2.2 ***Controllable anatomic site screening for the head***

Table 2.4 Chart used to record speed and accuracy during typing test or marked keyboard test

CAS	1	2	3
Description			
Track time			
Recorded selected time			
Calculated select time*			
Error type: A—adjacent T—track S—second site R—remote			
Error number			
Effort			
Other comments			

*Calculated select time $= \dfrac{\text{total} - \text{track time}}{\text{keys requested} - 1}$

with the dots are pressed in any order. For both tests, timing should include both track and select time. Track time is recorded from when the user is instructed to start until the first key is pressed. Select time is recorded from when the user is instructed to start until the sentence is complete or all of the keys with the dots have been pressed. To calculate select time, subtract the track time from the select time and divide this by the total number of keys in the test minus one:

$$\text{Select time} = \frac{\text{Timed select time - track time}}{\text{number of keys in test - 1}}$$

The keys in the test are the number with a dot on top of them or the number of key strokes needed to complete the test sentence during a typing test.

During the tests to measure speed, the number
and types of errors are recorded. The types of errors
2.28 include those that are adjacent (A) or remote (R) to
the intended key, those which are activated in the track
(T) between the last key activated and by a second (S)
anatomic site. For example, when an index finger is
used as an isolated pointer, an error is recorded if another finger activates an undesired key.

References

Barker, M., and Cook, A. (1981). A Systematic Approach to Evaluating Physical Ability for Control of Assistive Devices. Proceedings of the Fourth Annual Conference on Rehabilitation Engineering. Washington, D.C.

Bergen, A., and Colangelo, C. (1982). Positioning the Client with CNS Deficits: The Wheelchair and Other Adapted Equipment. New York: Valhalla Rehabilitation Publications, Ltd.

Cook, A., and Barker M. (1982). A Systematic Approach to Choosing Interfaces for Assistive Devices. Final Report submitted to Department of Education for Field Initiated Research Project Grant #G007902261, CFDA #13,443c.

Trefler, E. (1984). Seating for Children with Cerebral Palsy, A Resource Manual. Memphis, TN: The University of Tennessee Center for Health Sciences, Rehabilitation Engineering Program.

Access Requirements for Persons with Moderate to Severe Orthopedic Disabilities

Introduction

Providing computer access, educational opportunity and meaningful employment for persons with severe physical disabilities is an important and challenging undertaking. With the advent of new technological capabilities, what has previously been a noble but impossible dream is now an immediate and pressing obligation. Persons severely disabled because of accident, disease or neurological disorder can, through the use of specialized computer access technology, be released from many of the limitations of these conditions. Communication, that vital linkage between one human being and another, can be enhanced, learning can take place, and, through access to a wide range of informational media, significantly improved opportunities for education, employment and societal contribution become available.

3.1 Perhaps more than any other identifiable population, severely disabled persons have been educationally disadvantaged and restricted from meaningful employment. It wasn't all that long ago that such persons were routinely labeled mentally retarded and relegated to perpetual care facilities as a matter of course. Recent advances in testing practices and augmentative communication devices have revealed that many such persons possess average to above average intelligence. Faced with this new information, we must now begin to consider innovative and effective methods for educating such individuals.

Education is a process which typically requires extensive communication between teacher and student. Such communication most often takes the form of spoken and written interaction. In the case of severely disabled persons who are unable to speak intelligibly or produce written materials with pencil and paper, the traditional educational process falters. Institutions of postsecondary education have responded to this issue by developing training programs in special education producing graduate instructors with the skills required to work with the severely disabled. Until very recently, however, nothing could be done to effectively reduce the effects of limited communication on the educational process of severely disabled persons. Through the use of adapted computer access systems, much can now be done to correct this difficulty.

The following section, "Computer Access Evaluation Techniques and Strategies for Individuals with Severe Physical Disabilities," describes the requirements of computer access systems for severely physically disabled persons with average to above average intellectual ability. As with the preceding portions of this book, the following text is intended to serve as a guide to what works, rather than a comprehensive discussion of all that is available. Instructors, counselors,
3.2 vocational rehabilitation staff and other members of the helping professions are often called upon to make decisions regarding technology and access issues on behalf of severely disabled individuals. Although access decisions would ideally be made only after a complete evaluation by a team of skilled professionals, travel difficulties, financial limitations and the present day scarcity of trained professionals in the field of computer access often make such ideals almost impossible to achieve. The majority of evaluation procedures and access technology recommendations are presently performed by diligent staff at K–12 institutions, vocational rehabilitation centers and special education facilities across the country. It is our hope that this guide will assist this dedicated group of individuals by providing a set of practical guidelines for evaluating the access requirements of severely disabled persons and selecting appropriate technology.

In general, we will be discussing access technologies for adolescents or adults which are suitable for singly or multiply handicapped, severely disabled persons with at least normal intellectual capacity. Our candidate might have sustained his or her disability through injury, birth defect, disease or neurological disorder. Typically, we would expect to see individuals without independent mobility and requiring fully motorized wheelchairs. Our candidate might be moderately to severely speech impaired or non-oral and require a full or part-time attendant. We would expect to see individuals who fatigue easily and who show evidence of learning disabilities and/or educational disadvantagement.

Unlike previous chapters of this book in which primarily software-based access systems for visually, learning and mild-to-moderately, physically disabled persons were discussed, the technology to provide access for severely physically disabled requires an emphasis on the best of both hardware and software-based access technologies.

Access Evaluation

Accurate access evaluations and technology recommendations for severely disabled persons can only be determined on a case-by-case basis. It is an exacting and lengthy process which should be systematically carried out. Please think of these materials as a set of guidelines and resources rather than a comprehensive "how to" text.

Seating

Seating is essential for effective computer access. Although it may seem odd to begin an introduction to computer access with a discussion of the importance of proper seating, experience has shown that in order for a disabled individual to work effectively, a comfortable, secure and stable seating arrangement must be established. Seating is a highly specialized field and should only be carried out by a skilled professional. It is strongly recommended that the services of a qualified rehabilitation engineer, occupational therapist or orthotist be enlisted to perform this task. Since endurance, range and mobility can be dramatically affected (both positively and negatively) by seating arrangements, any necessary modifications should be made prior to beginning a computer access evaluation.

The focus of this book is on computer access rather than the use of augmentative communication devices. Augmentative communication devices, however, will be used and described within their role as alternative keyboard systems.

3.4

Keyboard Access

The computer screen and keyboard are the primary interface between people and computers. Therefore, how the disabled individual will be provided with keyboard access is a pressing question. The first step involved seating issues; the second step addresses matching physical ability to the access options available to the individual. A practical, step-by-step method for determining if a keyboard can be used is available in Chapter 2 of this book. The following text describes systematic evaluation tools for making important access decisions based on the possibilities of a person with limited physical ability.

Since, in many instances, severely disabled persons will be unable to use the standard computer keyboard, alternative systems will need to be provided. Depending upon the individual's physical and cognitive ability, and on what selection options are available, keyboard access will fall within two general categories: direct selection and scanning. *Direct selection systems* provide various methods through which the user physically selects the key to be pressed. This can be accomplished through specially designed keyboards with oversized keys, optical pointers or highly specialized systems capable of determining what letter the user is looking at. *Scanning systems* typically move a selection indicator from one character to the next on a keyboard emulator or graphically simulated keyboard displayed on the computer screen. When the pointer rests on the desired letter or symbol, the user activates a switch which sends the selection to the computer screen as if it had been directly typed from the keyboard.

3.5 Efficient Computer Use

Once an effective method of keyboard access has been established, the third step in the process can take place: using the computer. In continuing our commitment to recommending access technologies which work with, rather than replace, commercially used applications software (i.e., WordPerfect, dBASE, Lotus etc.), every effort has been made to utilize techniques which incorporate software- or hardware-based access systems which are transparent to popular software programs. Over the last two years, significant advances have been made in the development of the highly specialized technologies required of computer access systems for persons with severe disabilities. The primary purpose of such systems is to enhance the speed, efficiency and accuracy with which the writing process can take place. The following section will provide you with an understanding of the capabilities such specialized access systems must possess as well as a means for matching access needs of a disabled individual with currently available, reliable, cost-effective access technologies.

To be given an opportunity to provide severely disabled persons with a means for dramatically broadening life's possibilities is a rare privilege. We are deeply grateful for the occasion to share this information with you, the professionals, whose day-to-day work and commitment make the implementation of new technologies a practical reality.

3.6 Computer Access Evaluation Techniques and Strategies for Individuals with Severe Physical Disabilities

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Introduction

Computer access by persons with severe physical disabilities can be facilitated through a variety of hardware and software tools (Brandenburg and Vanderheiden, 1987). These tools, along with strategies for their use, methods for minimizing fatigue, maximizing speed and improving accuracy, are the means for developing efficent use of computer applications. A systematic evaluation approach should be followed in determining the most effective tools and strategies for an individual student. This chapter discusses the tools, strategies, and evaluation methods which comprise such an approach.

Tools and strategies for people with severe physical disabilities include a variety of input devices, enhancement tools, and selection and acceleration strategies (Figure 3.1). Input devices include keyboards, switches, the mouse, joysticks and optical pointers. Enhancement tools are used to modify the input device. These include headwands, mouthsticks, keyguards and trays, or tables, to adjust keyboard height and angle. Selection strategies include the use of direct selection or scanning to select the choices (i.e., alphabet, control characters) to be sent to the computer. In either case, the selection strategies should be transparent to the application software.

The evaluation methods presented in this chapter are intended for use by health care or educational pro-

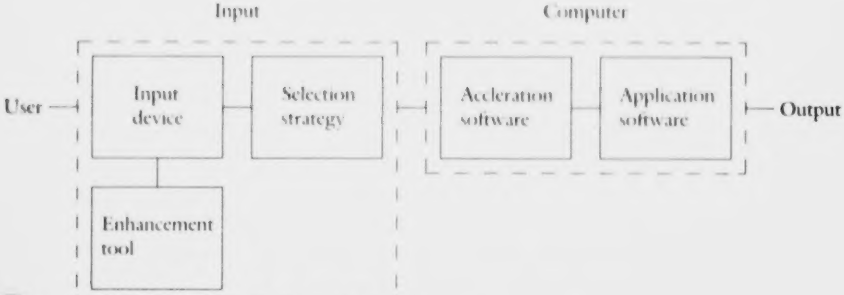


Figure 3.1 ***Block diagram of an adapted computer system***

fessionals, with experience working with computers, and persons with physical disablility. Although these evaluation methods may seem extensive, they are by no means complete, when considering the diverse and complex needs of persons with severe physical disabilities. This chapter presents the practical experience of a multidisciplinary team integrated with a systematic evaluation method described by Barker and Cook (1981). The multidisciplinary team works with severely physically disabled children and adults at the Children's Hospital at Stanford, Rehabilitation Engineering Center. The team includes a rehabilitation engineer, an occupational therapist and a speech and language pathologist. These evaluation methods will function best when used with persons who are not able to use a standard keyboard and/or mouse; are unable to use a keyboard with adaptations described in Chapter 2; or are able to type only at very slow typing rates (i.e., five
3.8 characters per minute). Some of the evaluation strategies presented in this chapter are not suitable for children, non-readers or for persons having some types of cognitive impairments.

Input Devices

Input devices are described by characteristics that are relevant to their operation. These characteristics include:

- **the number of independent choices or activation sites (e.g., number of keys on a keyboard)**
- **the size of the input device (e.g., keyboard size)**

- **the size of each activation site (e.g., key or switch size)**
- **the distance between activation sites (e.g., distance between keys)**
- **the sensitivity (e.g., force required to activate the key or switch)**
- **feedback which includes (1) travel (i.e., movement of the activation site), (2) auditory (e.g., mechanical or electronic click), (3) tactile feedback (e.g., resistance felt when pressing a key)**

The classes of input devices are based on the number of independent choices or activation sites on the device. These classes include single switches, switch arrays and keyboards. Single switches have one activation site which is used to make one choice, either ON or OFF. Switch arrays (e.g., a group of single switches) include two to 10 activation sites. Keyboards include more than 10 activation sites, and often as many as 128.

Single Switches

Single switches are used to make one choice, ON/OFF. Without complex selection strategies and acceleration software, single switches are very restrictive. Single switches are represented by a wide range of activation characteristics. Activation characteristics include light-to-heavy pressure, movement and puff/sip (Table 3.1). Note that one group of switches is activated by movement and not necessarily by applying pressure.

Table 3.1 Activation characteristics of commercially available single switches

Activation characteristic	*Product name*	*Manufacturer*
Heavy pressure	Tread	Zygo Industries, Inc.
	Treadle	TASH, Inc.
	Single rocking lever	Prentke Romich Company
	Thumb	Zygo Industries, Inc.
	Square pad	TASH, Inc.
	Plate	Don Johnson Developmental Equipment, Inc.
Light pressure	Touch	Zygo Industries, Inc.
	Lever	Zygo Industries, Inc.
	Mounting	Don Johnson Developmental Equipment, Inc.
	Pushbutton	Zygo Industries, Inc.
	Pressure	Luminaud, Inc.
	Platform	TASH, Inc.
	Plate	TASH, Inc.
	Plate	Zygo Industries, Inc.
	Pinch	Steven E. Kanor, Ph.d., Inc.
	Pillow	TASH, Inc.
	Membrane plate	Crestwood Company
	Bite	DU-IT Control Systems Group, Inc.
Movement	Tip	TASH, Inc.
	Tilt	Steven E. Kanor, Ph.D., Inc.
	Mercury tilt	Luminaud, Inc.
	Infrared switch	Words + , Inc.
	Photo cell switch	Steven E. Kanor, Ph.D., Inc.
	P-switch	Prentke Romich Company
	Magnetic finger	Luminaud, Inc.
Puff/sip	Sip and puff	Steven K. Kanor, Ph.D., Inc.
	Pneumatic	Zygo Industries, Inc.
	Pneumatic	TASH, Inc.
	Pneumatic	Prentke Romich Company
Voice	Voice activated	Steven E. Kanor, Ph.D., Inc.

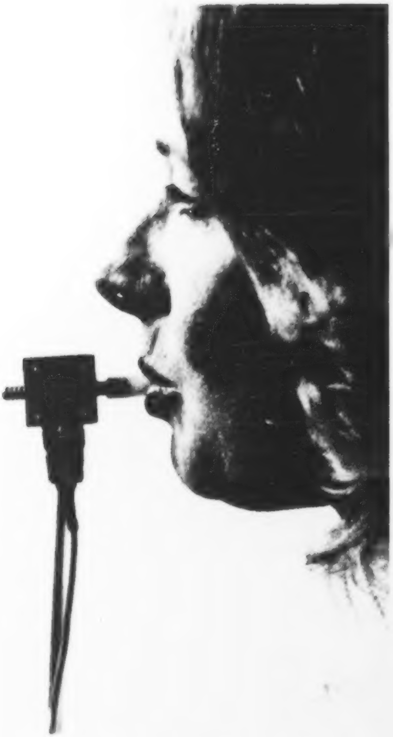


Figure 3.2 Puff/sip switch

Another group of switches, puff/sip (Figure 3.2), are not necessarily controlled by breath (e.g., air flow from the lungs) but by the change of air pressure. A puff/sip switch placed in the mouth can be activated by the change in pressure in the oral cavity. As a result, this switch can be used by people who are dependent on a respirator.

Switch Arrays

Switch arrays (Figure 3.3) provide two to five independent choices using a group or array of single switches. When used with computer applications, switch arrays are used for mouse emulation (e.g., to move a cursor around a display and make selections from a menu). Switch arrays are often packaged to stabilize the switches and increase their ease of use.

Joysticks

Joysticks can also be used for mouse emulation. Joysticks are either discrete or proportional. A discrete joystick can provide four to nine choices and is used like a switch array. A proportional joystick produces

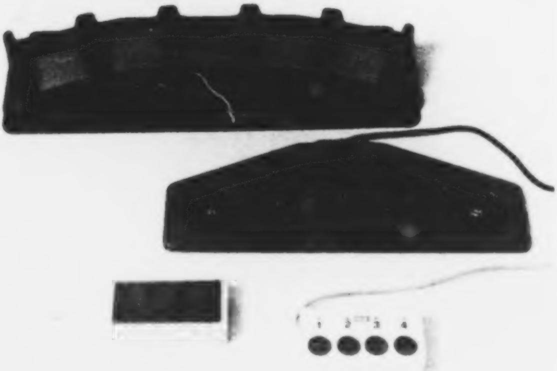


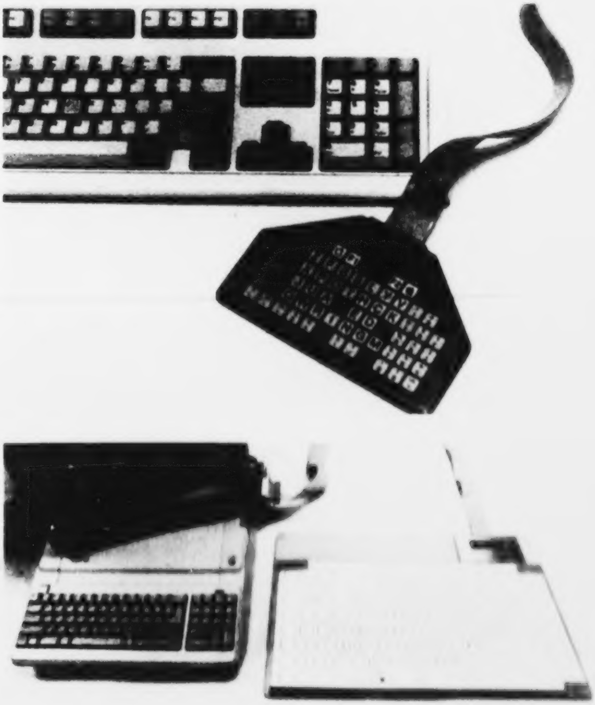
Figure 3.3 Commercially available switch arrays

an output that can take an infinite number of different values between zero and some maximum value. This is the type of joystick typically used with most of the popular computer games as well as to control a power wheelchair. A proportional joystick is dependent on the resolution of the computer or the input system (e.g., augmentative communication system). If the user is an extremely controlled driver of a powered wheelchair, and does not have the range or strength to use a standard keyboard (perhaps a student with Muscular Dystrophy), a joystick should be considered as an input device.

Keyboards

Keyboards range in size, number of keys and activation characteristics. Size is usually delineated as standard, mini or expanded (Figure 3.4). Keyboards consist of raised keys or a smooth membrane with activation sites. Keys are usually the most desirable due to the multisensory feedback provided by a key when it is pressed. Keys that click and move when depressed provide visual, auditory and tactile feedback. Membrane keyboards do not usually provide such feedback. The user must examine what is printed on the monitor of the computer system to determine if the activation has been registered. The primary advantage of the membrane keyboard is the wide range of keyboard sizes and number of keys. Overlays with words and phrases, pictures or icons, as well as the alphabet, can be used to label the activation sites on a membrane keyboard. It is difficult to relabel raised keys with words and phrases (when using macros, for example.) Additionally, few raised-key keyboards offer the range of key sizes (very large to very small) found on membrane keyboards.

Membrane keyboards usually provide better pro-



3.14

Figure 3.4 Examples of keyboards

tection of the electronics in the keyboard. However, plastic protective covers can be used on keyboards with raised keys providing protection from moisture and grime, thus extending the life of the keyboard. Plastic covers can also be used to temporarily relabel a keyboard. Letters, words and color coding can be attached to the cover. The layout of the alphabet and control characters can be rearranged on the keyboards of many commercially available computer keyboards. Macro and keyboard redefinition programs, included with

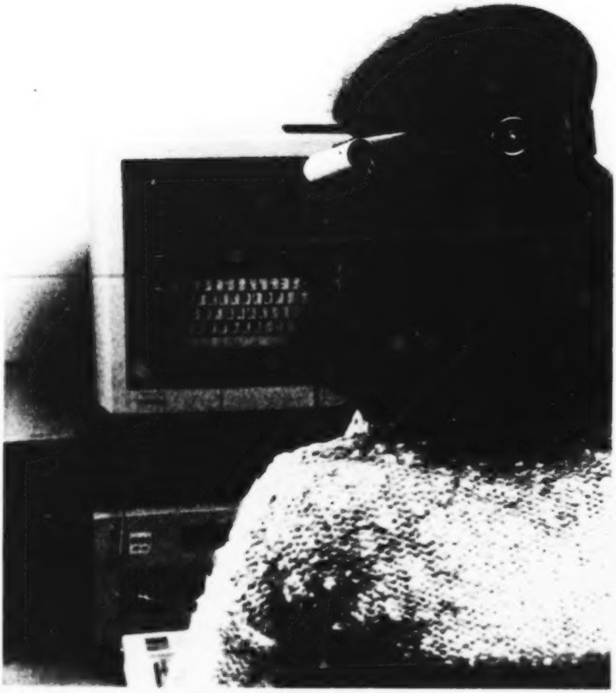


Figure 3.5 Optical pointer

many computers or available as commercially available software, can be used for this purpose.

There are keyboards that are activated by methods other than pressing a key. These methods include looking at a choice (i.e., eye gaze); pointing at a choice using a light (i.e., optically activated [Figure 3.5]); or voice (speech recognition). These methods can facilitate direct selection and produce faster typing rates for people who otherwise might use a single switch or a headwand.

Mouse, Trackball

The mouse and trackball offer an output similar to a proportional joystick. Memory resident software is available that facilitates the selection by a mouse or trackball of a character from a display on a computer monitor (Figure 3.6) The mouse requires some range of motion from the shoulder and hand grasp if operated by pushing it around with the hand. The trackball remains in place, and the fingers, a mouthstick or a headwand can be used to rotate the ball in place.

If a mouse is required for an application and a mouse or trackball cannot be used, mouse emulation should be considered. Mouse emulation can be accomplished by using switch arrays or a discrete joystick. These alternate input devices require an interface

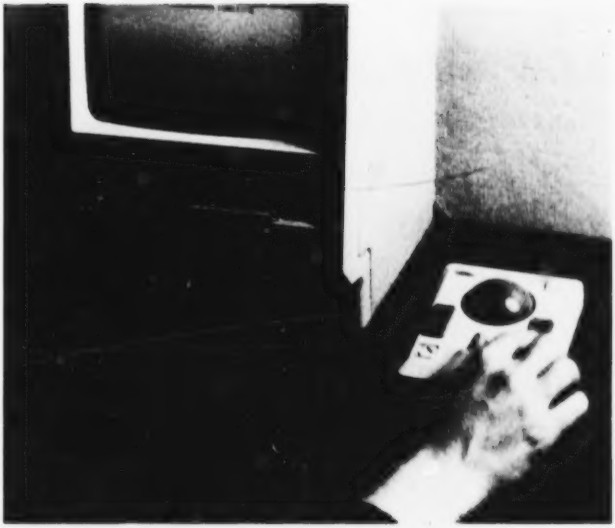


Figure 3.6 Using a trackball for alphabet selection

board, that plugs into an expansion slot inside of the computer, or an interface device with a cable, that plugs into a parallel or serial connector on the computer.

Enhancement Tools

Enhancement tools can make it possible to use an input device with more independent choices (keys or switches) by minimizing errors and maximizing speed. Typically, these tools are hardware add-ons to the input device. Enhancement tools include tables and other surfaces with adjustable height and/or angle for input devices, keyguards for keyboards, slot controls for switch arrays, headwands, hand-held pointers and mouthsticks and their docking systems. (Docking systems are devices which allow mouthsticks or other pointers to be "parked," when not needed, and then retrieved for later use.)

During the evaluation process, enhancement tools should be considered as a method for improving student performance using an input device. It is important to realize that enhancement tools can interfere with, as well as improve, performance with a particular input device. For example, a keyboard keyguard may reduce the number of errors but, at the same time, significantly reduce typing speed. The ratio of benefits versus disadvantages should always be carefully weighed when identifying the best combination of input device and enhancement tools.

Selection Strategies

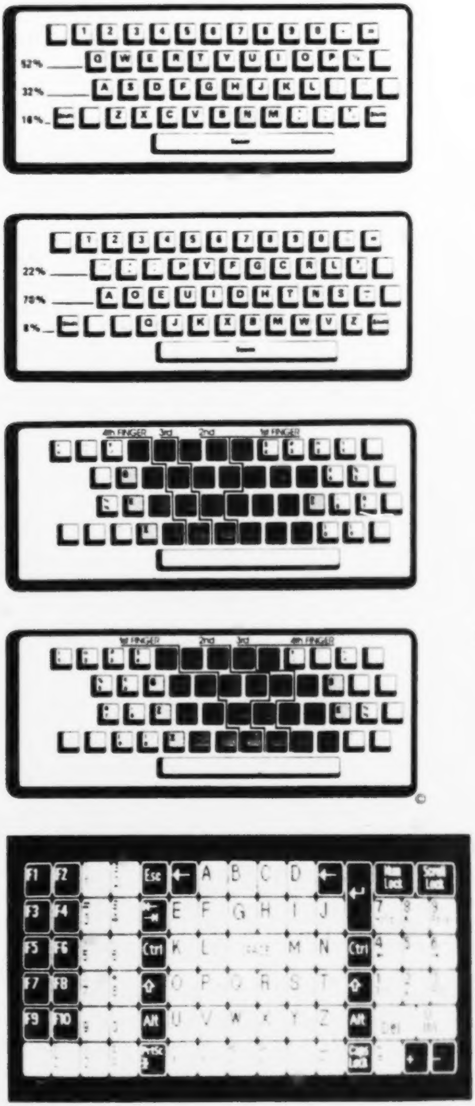
The effective use of any input device is dependent on the selection strategies. Input devices are used to make selections which might include letters of the alphabet or control characters. Choices are presented to the input device user on a selection display. The selection display can be laid out on the keys of a keyboard, on the computer screen to resemble the keyboard, or on a separate panel (such as those used for scanning with a single switch or for optical pointing). Selection strategies include the position of choices on a selection display and the method of selection. Direct selection and scanning are two types of selection techniques.

Direct Selection

Direct selection is the independent selection of each choice. Direct selection is used with keyboards, optical pointing and eye gaze systems.

3.18 Alternate keyboard layouts (Figure 3.7) may facilitate faster or more accurate use of a keyboard. The standard typewriter keyboard layout (Qwerty) is designed to slow a typist down. It was developed at a time when keyboards were mechanical and many people's fingers could type faster than the keyboard could accommodate. The Dvorak keyboard is strategically designed so that the keys pressed most often are under the strongest fingers. Dvorak keyboards are designed for both hands as well as independent left or right hand use.

When using a single pointing device with which to type (headwand, mouth stick, single finger, etc.) students frequently need to look at the keyboard in order to locate the desired key. Although the Qwerty keyboard can be used, an alphabetically arranged keyboard can help with the search process. Centering the location of the letters on the keyboard layout (using Smartkey or any other keyboard recon-


52%
32%
16%
22%
70%
8%
4th FINGER
3rd
2nd
1st FINGER
1st FINGER
2nd
3rd
4th FINGER
©
F1
F2
Esc
A
B
C
D
Num Lock
Scroll Lock
F3
F4
E
F
G
H
I
J
F5
F6
Ctrl
K
L
M
N
Ctrl
F7
F8
O
P
Q
R
S
T
F9
F10
Alt
U
V
W
X
Y
Z
Alt
PrtSc
Caps Lock

Qwerty

Two-handed
Dvorak

Left-handed
Dvorak

Right-handed
Dvorak

Alphabetic

Figure 3.7 Keyboard layouts

figuration software) is also helpful when using a pointer, as it limits the range that must be travelled when making a selection. Repeatedly used words or phrases can also be included in the layout for some keyboards.

Morse Code requires the use of one, two or three switches to type out a code for the letters of the alphabet and control characters. The Morse Code can be a very powerful technique when using switches. For some disabled students, it can be faster or easier to use than the scanning techniques. It is particularly useful for individuals with visual-perceptual problems.

Scanning

Scanning is the sequencial presentation of choices and is used with a single switch or a switch array. *3.20* Switches are used to control the scanning and to select the choice. When using a single switch or a switch array, scanning methods are used to facilitate choices from a selection display of the alphabet, control characters, words and phrases. There are several scanning methods. The most appropriate method for a particular individual will maximize the speed and accuracy of his/her ability to send characters to the computer while taking into consideration the student's physical control of the input device and visual perceptual skills.

Selection strategies are either resident in the computer memory or are incorporated into an input device that is connected to the computer. In either case, the selection strategy should be transparent to the application software.

Step or manual scanning. Step or manual scanning is used with one or two switches. Each time a switch is pressed, the scan moves to the next choice

(A to B to C, etc.) Selection can be made with a second switch or can occur automatically if the pointer remains on a selection for a set period of time.

Auto scanning. Auto scanning is the automatic presentation of each choice. A switch is pressed to start and stop the sequential presentation of all the choices. The speed of scanning can be slowed or speeded up according to the needs and abilities of the user.

Row-column scanning. When using a scanning system, choices can be presented one after another in a linear fashion or as groups. When presenting choices as groups, the switch is used to select the group and then a choice within the selected group. A common group presentation strategy is row-column scanning. On a matrix of choices, the rows are presented one at a time. The switch is used to stop the 3.21 scan at the row with the desired choice. The scan then proceeds through the selected row, one choice at a time, and the switch is used again to stop on the choice. Group-row-column scanning (Figure 3.8) can be faster than row-column or linear scanning but requires more switch activations. Grouping can be in the form of the top and bottom half of a scanning matrix or three or four sections moving from the left to the right of the display.

Directed scanning. Directed scanning can be used with two to five switches. A switch is selected for the direction of the scan. For example, with 4 switches: one switch is used to move the scan in a upward direction, one to move down, one to move left and one to move right. A choice is selected after a set period of time or with a fifth switch. A directed scan with two switches can use one switch to scan vertically up or

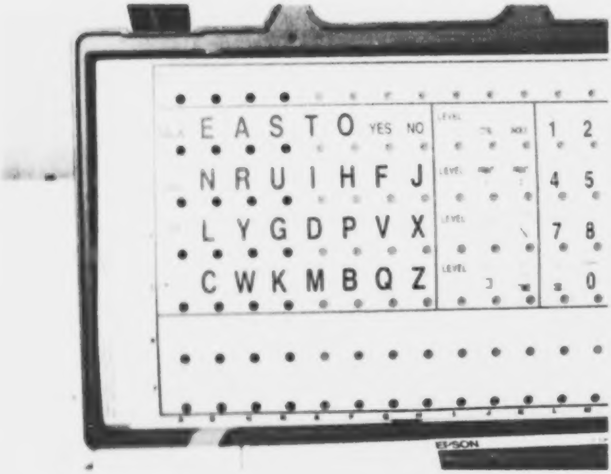


Figure 3.8 A highlighted group in group-row column scanning

down and the other switch to scan horizontally left or right. Directed scanning has the potential to be a faster scanning technique than group scanning presentations but it requires more user control.

Auditory Scanning. For people with visual impairments or visual perceptual problems, auditory scanning can facilitate the use of a single switch. Each choice is spoken during auditory scanning. Auditory scanning tends to be slower than visual scanning but can improve accuracy for people with anticipation problems or those that are able to process auditory information more easily than written information. It is very useful for non-readers.

Automatic Scanning. Automatic scanning techniques can be very difficult to use. Many people attempt to anticipate the movement of the scan and, as a result, tend to jump the gun and activate the switch before the desired choice is presented. Alternately, the physical control of a person's motor movement may be restricted by an abnormal reflex pattern that results in pressing the switch after a choice has been presented in the scan. These problems can often be resolved by slowing down an automatic scan, using a step scan or by training scanning strategies. The key to using automatic scanning at a fast scan rate is to look only at the desired choice and activate the switch when that choice is highlighted or presented (Weiss, 1983). Users must be discouraged from following or tracking the scan with their eyes.

Non-linear scanning speeds. Non-linear scanning speeds, currently available only on the Zygo Industries, Inc. Tetrascan, can also decrease the time to make a selection. The scanning speed at the top of the scanning matrix starts out slow and increases. This makes it easier for some people to make an accurate selection at the beginning of a scan without having to maintain the slow scan for the rest of the matrix.

Fixed and Transient Scanning Arrays

Scanning arrays and matrices are either fixed, with all of the choices visible to the user at the same time, or transient. The choices in a transient array change when a selection is made. For example, a section of a computer-based dictionary of words can be selected with a letter from an alphabet array. Transient arrays are presented on a monitor or an electronic display (i.e., LED, LCD) where the position of the selections can be easily changed. Transient displays are used to increase the number of choices available for selection. The capacity of such systems to present full words and phrases is particularly useful for individuals with spelling problems or those who make selections slowly when using a single switch and scanning. However, persons able to use fast scanning speeds may find that a transient display can actually slow down their selection rate.

Acceleration Strategies

Acceleration strategies are used to increase speed and accuracy when using application software. These strategies are included in software that is either incorporated into an input system or available in the memory of the computer running the application software. Acceleration strategies include the storage and recall of words, phrases and sentences and prediction or anticipation techniques. Often used vocabulary stored in 3.24 the memory of an input device or a computer system can be recalled using number codes, abbreviations or other symbols (e.g., pictures, icons). Additional programs are available which reside in computer memory and predict letters (characters) or words based on the frequency of use or recency of use.

Acceleration strategies typically focus on reducing the number of keystrokes for typing words and phrases. For individuals with slow typing rates, acceleration strategies can be extremely useful. Conversely, for persons with fast typing rates, acceleration strategies may reduce input speed. It is important to note that persons with typing speeds in excess of about 15 to 20 characters/minute may find such programs more of a hindrance than a help.

Many features of word processors and other application software can also improve a user's efficency. Spelling checkers, thesauruses and grammar checkers are valuable tools.

Augmentative Communication Systems

Augmentative communication systems (ACSs) can incorporate an input device, and selection and acceleration strategies. ACSs can be used as an input system (e.g., keyboard) to a computer running typical software applications (such as word processors, spreadsheets and database managers). ACSs are typically specialized portable computers. The software run in the computer of an ACS is dedicated to producing written or printed output for communication. Some of these systems can be used as basic word processing systems but tend to be very limited. An ACS is typically used when its unique input system matches the abilities of a severely physically disabled person. Many individuals will also use an ACS for spoken communication. Spoken communication requires optimal speed and accuracy to be effective. If a person is already a good user of an ACS, the system should be seriously considered as an input to a computer as a means of running other application software.

ACSs can output to a speech synthesizer or a visual display (i.e., monitor, LED or LCD display) and can send a code (i.e., ASCII characters in parallel or serial RS-232 formats) directly to a computer. Those ACSs capable of sending a code to the computer are suitable for use as keyboard emulators. ACSs usually require interface boards that are plugged into expansion slots inside the computer running the desired application software.

For individuals who are not able to use their speech to communicate, a stationary computer system can be used as part of their ACS. It is absolutely essential, however, that the speech impaired person have a portable augmentative communication system which can be used in all the environments in which the individual needs to communicate.

Table 3.2 Augmentative communication devices (ACD) that can be used as part of a computer access system

ACD	*Manufacturer*	*Input devices*	*Input strategies*
EvalPAC	Adaptive Communication Systems, Inc.	Keyboard Optical pointer Single switch Switch array Joystick	Direct selection Morse code Row-column scanning Group-row-column scanning Directed scanning
LightTalker/ TouchTalker	Prentke Romich Company	Keyboard Optical pointer Single switch Switch array	Direct selection Averaged pointing Row-column scanning Directed scanning

3.26 Table 3.2 is a list of ACSs that have been used as input devices to a computer. The ACSs listed are wheelchair portable. These systems are typically placed on a laptray that is attached to the wheelchair or on a wheelchair mounting kit (Figure 3.9).

Determining an Appropriate Input System

Input Device Identification

The first step in determining an appropriate input system is to identify the input device. The selection and acceleration strategies should not be considered until this first step is complete. The premature introduction of selection and acceleration strategies will interfere with the evaluation process to determine the best input device. There are three basic evaluation steps for identification of an input device (Barker and Cook, 1981):

1. Identification of anatomic sites with voluntary, controlled movement and analysis of the movement
2. Matching the characteristics of anatomic sites to potential input devices
3. Quantitative analysis of potential combinations of anatomic sites and movements with input devices

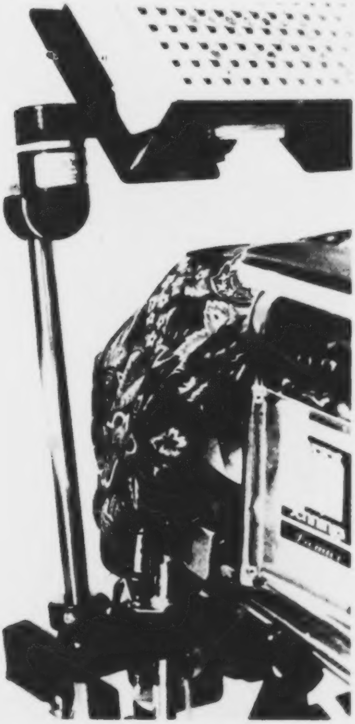


Figure 3.9 Augmentative communication system (ACs) stabilized on a commercially available wheelchair mounting kit

Several tools are essential to the evaluation process presented in this chapter. The Basic Evaluation Kit (Figure 3.10), in addition to a standard computer system, should be readily available to facilitate screening for useful input devices and strategies. By itself, the kit may not be complete enough to delineate the optimal input device and strategy. The actual devices and intended application are often needed to substantiate evaluation results. Use of the evaluation process will shorten the time required to determine the optimal input device and reduce the amount of trial and error for the client prior to successful use of an input device and strategy with a computer.

- Stop watch (electronic preferrable—quiet)
- Tape measure
- Protractor
- Light and/or tone feedback device (i.e., Trace Multibox, others)
- Range sheets (Figure 2.1, made of stiff cardboard covered with clear contact paper or laminated)
- Switches
  - Tread
  - Lever or mount
  - Light touch
  - Puff sip
- Mouthstick (dowels with mouthpiece, hard plastic tubing)
- Headwand
- Optical pointer (lightbeam, Headmaster, LROP, Freewheel)
- Height adjustable table for wheelchair access (hospital table, computer table [Global])
- Dycem, duct tape to stabilize controls
- Software
  - Multiscan
  - Scanning program
    - Keyboard speed Filch, others
- Evaluation forms (Figures 3.11 and 3.13)

Figure 3.10 Basic Evaluation Kit

Identification of Controllable Anatomic Sites (CASs)

When considering use of keyboard alternatives or input devices other than keyboards and the mouse, there are several possible sites that should be considered. The most likely sites are the hands, head and feet, but any site that a person can voluntarily move should be considered. If any of the sites identified can be used as a pointer, a keyboard should be considered (Refer to Chapter 2).

Range, Resolution and Strength

Begin an evaluation by listing those anatomic sites that the student identifies as controllable as well as those sites that seem to have control based on observation. For each controllable anatomic site (CAS) listed, describe the movement by the direction, range, resolution and strength of the movement, as well as the position of the surface acted upon by the movement. These can be quantified by addressing the area which can include the input device or target, the size of the target, the distance between multiple targets and the postion of the target in space.

An evaluation form, Screening for CASs (Figure 3.11), is used to record information and compare the CASs and their movements. During the evaluation, the targets are the squares and corners of the squares on the range sheets (see Figure 2.1). The range sheets are used to evaluate the anatomic sites that have potential for direct selection; the hands, the head with a headwand or mouthstick and the feet. The student should be asked to touch the squares and then the corners of the squares on the range sheets. If a client is able to clearly touch a corner, that client de-

Figure 3.11 *Screening for CASs evaluation form*

Client ______________________ Date ______________

Activation sites (circle)	Head side L/R back forehead eyes mouth tongue bite puff/sip chin	Shoulder Upper Arm Elbow Lower Arm Wrist	Hand L/R fingers side palm	Upper leg Knee Lower leg	Feet
Movement/angle (describe)					
Range (inches)					
Resolution (fine/gross)					
Strength (weak/strong)					
Vision/hearing					

Comments:

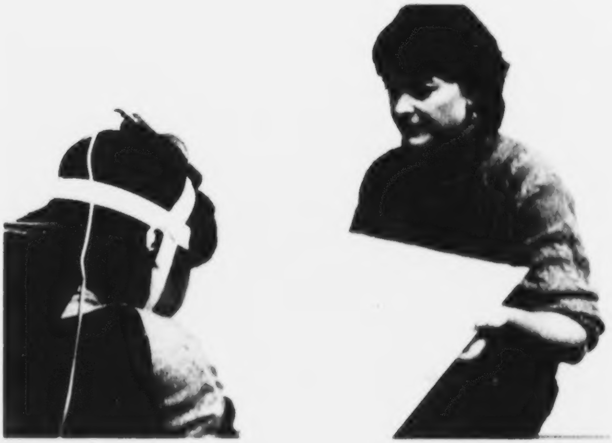


Figure 3.12 Using the range sheet during an evaluation

monstrates fine resolution. If the client is not able to clearly indicate a corner of a square but is able to indicate the whole square, the client demonstrates gross resolution. A range sheet (Figure 3.12) should initially be positioned as directed by the student. It should be repositioned to evaluate and compare other possible movements of an anatomic site. Repositioning is based on attempting to center the range sheet around the center of the functional range of the client. The range sheet should be used on not only a flat surface but angled in space, even considering the vertical plane for placement.

It is important to use a range sheet for the screening rather than a switch or keyboard. The use of a switch or keyboard at this stage can influence the performance, requiring more time for the evaluation, and result in selection of an input device that is not optimal.

During the screening process, it should be noted whether there are known hearing or vision problems. These problems can interfere with performance using an input device and strategies, as well as limit the ability to read from a monitor or listen to a speech synthesizer.

Those CASs with the greatest potential for use with input devices are those with:

1. **the largest range**
2. **fine resolution**
3. **controlled strength**
4. **no interference by reflexes or other anatomic sites**

When considering the anatomic sites, also consider speech, eye gaze and head control. The use of speech for computer input is discussed in Chapter 2. 3.32

Eye movement can be used to trigger a single switch or to make direct selections. The person must be able to control either eye gaze, eye blink or eyebrow movement (i.e., wrinkle of the forehead). For eye gaze to be useful, there must be no nystagmus (rapid, uncontrolled eye motion) and the person must be able to maintain the eye gaze on a choice for a few seconds, with practically no head movement. Eye blink must be very deliberate.

To evaluate head control, start by analyzing head movement. Measure the rotation and tilt of the head to left and right and how far the person can move the head forward and back. Rotation is the turning of the head to the side. Tilt is moving the ear closer to the shoulder. When using rotation and tilt, it is important to consider what is happening to eye position. Some people cannot separate head movement and eye movement. If a person cannot maintain eye contact with the computer display during these movements, input to the computer will be slowed down. Eye contact is generally easier to maintain when using head tilt.

Matching CASs to Input Devices

The second evaluation step is the matching of the characteristics of the anatomic sites to the characteristics of the potential input devices. The characteristics of the input devices include the number of independent choices or activation sites (e.g., number of keys on a keyboard); size of the input device; size of each activation site; distance between activation sites; sensitivity and feedback, which includes travel (i.e., movement required of the activation site to produce a response); and auditory and tactile feedback.

Three CASs with the greatest potential for use with an input device should be considered. The range and resolution are used to identify the type of device that can be used (Table 3.3). A person's strength, as well as sensory skills, are used to determine the feedback characteristics of the device. For example, if the range and resolution indicate that single switches should be considered, the type of single switch can further be delineated by what is known about the student's strength.

If a person demonstrates a range as large as a standard keyboard and fine resolution, refer to Chapter 2 to evaluate for the use of a standard keyboard.

Head movement can be matched with switch arrays around the head, with a headwand, or mouthstick, and a standard, mini or expanded keyboard, or an optical pointer. When using a headwand, the pointer can come from the chin, the top or side of head. User

Table 3.3 Matching range and resolution to types of input devices

Range	*Resolution*	*Input device*
Large	Fine	Keyboard, mouse
Large	Gross	Expanded keyboard Large switch array
Small	Fine	Small keyboard Trackball Joystick Small switch array
Small	Gross	Single switch

preference is usually the deciding factor during the
selection process. The student should have an opportunity
3.34 to practice with each of these pointer positions.
The length of the pointer and the position of the
keyboard also play a role in the effective use of a headwand.
The length should be the minimum length required
to access the full keyboard without requiring
the user to bend excessively from the trunk or the
neck. The keyboard should be placed at a height just
below the user's shoulders. It is often helpful to angle
the keyboard at about 30 to 45 degrees. The length
of the pointer and the distance between the user and
the keyboard should be adjusted to accommodate this
position.

When considering the use of a keyboard with a mouthstick or a headwand, also consider using an optical pointer. Try a light beam-type device such as an ACS Light Pointer or the Prentke Romich Company Viewpoint Optical Indicator. Ask the student to point to large targets such as those on the large range sheet

(Figure 2.1). If the student does not have immediate success, the student should be given an opportunity to practice with the device. If the student is able to point to the corners of the squares, devices that use optical pointing should be evaluated.

The optical pointers that can be used as input devices are available with several commercially available products including the Prentke Romich Company LightTalker, ACS EvalPac, Words+ LROP (IBM Compatible), Personic's HeadMaster (Macintosh) and Freewheel (IBM, Macintosh). The ACS EvalPac optical pointer shines a red light onto the selection display. This system is one of the easiest to use with an optical pointer due to the visual feedback provided by the red light. The red light activates a matrix of sensors that correspond to choices. Other optical pointers rely on the feedback from the selection display. The selection display is usually a separate computer monitor from the one being used for an application (e.g., Words+ LROP) or the selection display is positioned on a section of the monitor used for the application software (e.g., Headmaster, Freeweel). When it is on the same monitor, the selection display is usually on the bottom of the screen or can be moved into other positions. The selection display can also be a matrix of lights that indicate where the optical pointer is directed (e.g., Prentke Romich Company LightTalker). The Prentke Romich Company LightTalker can be used by individuals that have difficulty maintaining the position of the optical pointer. The positions that are being pointed at with the optical pointer can be averaged over a set period of time and a likely selection made.

Optical pointers can facilitate fast speeds using direct selection. Some people who use a headwand or a mouthstick effectively can improve their ability to access a computer by using an optical pointer. Persons unable to use a headwand or mouthstick may be able to use an optical pointer to facilitate direct selection. Optical pointers have proven to have greater application than previously suspected. The primary disadvantage in using an optical pointer is the increase in equipment expense.

Quantitative Evaluation

The third step in identifying an input device is a comparative analysis of the potential combinations of anatomic sites and movements with input devices. This analysis is used to determine a ranked list of the most effective combinations of anatomic sites and input devices. Following this analysis, the possible selection and acceleration strategies should be considered and
3.36 evaluated to determine what the person should actually
use with a computer application. The ranked list is needed because it is often the case that, based on an application or the use of strategies, the best input device will not necessarily be the one that is at the top of the list during the evaluation period.

Evaluate at least three combinations of anatomic site, movement and input device. For each combination, it is absolutely essential that the input device be stabilized on a stationary surface. If someone holds the device or if the device can be moved out of the desired position, the results of the quantitative evaluation will not be valid.

The evaluation should consist of qualitative as well as quantitative components. The quantitative evaluation includes measuring frequency or rate and accuracy. To determine initial scanning characteristics, reaction times are measured. The qualitative evaluation includes monitoring of fatigue and learning to use the device. If a person has not used an input device on a regular basis, learning to use the device will affect performance. The quantitative measures will often improve after a period of use. For example, optical pointers are initially very difficult to use. When first evaluated, a person may be very slow and make many errors. With practice, however, this tool can facilitate fast direct selection. If the student is interested and motivated to develop the skills required to use an optical pointer, he/she should be given the opportunity to practice for several days or weeks and then be reevaluated.

Potential Direct Selection

If a person is able to use his or her hands and type on a standard, mini or expanded keyboard, use the quantitative evaluation strategies described in Chapter 2. During the evaluation process, consider rearranging the keyboard in alphabetical order, in a layout of keys around a center point, or as a Dvorak keyboard. The typing rates and errors should be compared to those attainable with other input devices and strategies, such as those using switches (e.g., Morse Code) or those controlled with the head (e.g., optical pointer).

Single Switch Evaluation

The successful use of a single switch is dependent on the selection of an appropriate input device and selection strategies. Performance measures should be used to develop a rank ordered list of switches. This list of switches must be completed before selection strategies are identified.

Evaluate at least three switches from Table 3.1

based on the matching of CAS to input device strategies. Usually more switches will need to be evaluated. For each of the switches, measure average activation, reaction and duration times. Use the single switch quantitative evaluation form (Figure 3.13) to record performance.

Activation Time. To measure activation time, ask the student to press the switch five times and stop. The time should be recorded from the time the switch is first pressed to the fifth time it is pressed. The rhythm of the switch activations is noted as either even or uneven. This is an indicator of the degree of control the person has with a switch. It is important to note whether the student is able to stop pressing the switch after the fifth press. If the student is not able to stop, this may lead to problems when using a selection strategy. 3.38 Other anatomic sites or movements should be considered or reconsidered if this occurs. This test is used to screen the switches. If a student cannot press the switch five times in less than 20 seconds, the single switch system is not a likely candidate.

Reaction Time. To measure reaction time, use a visual stimulus such as a flashlight or a computer. Ask the student to press or activate the switch when the flashlight turns on or when a character appears on the monitor. The time, from the tester providing the stimuli until the switch is pressed by the student, should be recorded in seconds. If the student presses the switch much faster than the tester is able to time, the student's reaction time is considered good and and should be recorded as less than one second. Some students are not able to see the visual stimulus and, in that case, an auditory stimulus such as a bell should

	Description	T	Activation time (sec)	Stop (Y or N)	Rhythm (even or uneven)	Reaction time	Duration
#1		1					
		2					
		3					
		4					
		5					
#2		1					
		2					
		3					
		4					
		5					
#3		1					
		2					
		3					
		4					
		5					
#4		1					
		2					
		3					
		4					
		5					

Figure 3.13 Single switch quantitative evaluation form

be used. If a person has good reaction times using the auditory stimulus, rather than with the visual simulus, auditory scanning should be evaluated.

Duration Time. To measure duration time, ask the student to maintain activation of the switch for 10 seconds. Count to 10 for the student. If the student is not able to maintain switch activation, selection techniques using maintained activation (e.g., directed scanning) should not be used.

Evaluating Selection Strategies

When using a single switch for the first time, the students should first be introduced to a linear auto scan. The student needs to learn to stop the scan at a designated choice. Initially, it is recommended that an array size of nine or 10 be used. It is important to instruct the student not to follow the scan with the eyes, but to watch only the choice, and wait to activate the switch only when that choice is highlighted by the evaluation device.

If the user is able to use linear auto scanning easily, row-column scanning should be evaluated. When introducing row-column scanning, use a selection display with a matrix of at least 30 potential choices. Place three to five targets or choices on the selection display. If the student is able to accurately select the targets, introduce the letters of the alphabet as choices. It is desirable to position the letters according to frequency of use (Figure 3.8) and then allow the user to practice and learn the positions. After a training period, speed and accuracy can be measured. If row-column scanning is effective, consider group-row-column scanning.

If visual scanning strategies are not useful, auditory scanning should be attempted as well as Morse code. Each of these strategies should be tried and, if they have potential, the alphabet should be introduced. The student should be given a practice period of several days before speed and accuracy is measured.

Best Results of the Evaluation Process

The best input device, enhancement tools, selection and acceleration strategies should facilitate input to a computer by the user at a rate which is comparable to that of an able-bodied peer for creative writing (production of approximently two to four pages per hour). Desirable typing speeds are approximately 30 to 60 characters per minute with an error rate of less than one error per 100 characters selected. A person should be able to work at the computer for at least an hour at a time for a total of five to six hours per day.

Janie: A Case Study

Students with profound orthopedic disabilities present a unique challenge to educators. In order to fully participate in the academic environment, these students often require many special services including personal attendants, tutors and on-campus transportation. Even with such services available, the nature of many profound orthopedic disabilities limits oral communication and greatly increases the time required to produce written work. These difficulties have been the ultimate barriers which no legislative action or heroic effort on the part of program administrators or student services personnel have been able to remove. And yet, the need among severely disabled persons for post-secondary education is critical. Disabled persons who lack college degrees are almost totally unemployed. After subtracting the substantial, and frequently ongoing, cost of medical expenses from the modest income provided through Supplemental Security checks, most severely disabled persons who lack college degrees find themselves in an economic category below that of inner-city Blacks.

Although computers have always held great promise for disabled students, until recently effective use of microcomputers by students with profound disabilities has been virtually impossible. The difficulty arises from a fundamental design characteristic of microcomputers: their users must be able to see the screen and manipulate the keyboard. Severely disabled individuals may be unable to accomplish either of these tasks. 3.42

Recent refinements in the field of adapted computer technology have been particularly significant for profoundly disabled students. In many instances, it is now possible to dramatically improve the speed and efficiency with which such persons can produce written material.

The process of providing access to adapted computer technology for a profoundly disabled college student is well illustrated by Janie, a young woman severely disabled by athetoid and spastic cerebral palsy who is not able to use speech conversation and has no functional use of her hands, arms, feet or legs.

Limited facilities and services available to Janie in her native state seriously reduced her educational opportunities prior to moving to California. In 1982, her family came to California so that she could attend a school which specialized in working with the severely disabled. Janie had used an ETRAN (a clear, plexiglass sheet covered with numbers and the letters of the alphabet used to spell out sentences one letter at a time) as her primary means of communication since she was very young. She had mastered the eye gaze strategy with her family but the system was ineffective with people who did not know her well. In addition to the ETRAN, Janie used a Prentke Romich Company Express III (a sophisticated, computerized device which provides communication by voice output through synthetic speech and a small printer) which she accessed through use of an optical pointing system to enhance her communication options.

Janie came to Monterey Peninsula College after receiving a diploma from a local high school. She was 23 years old, highly motivated and eager to learn. As a result of limited educational opportunities, Janie had serious deficits in many basic skills areas. To be a successful college student, her basic skills level, and the ability to communicate effectively and produce written materials would all need to be dramatically improved.

After extensive consultation with Janie, a speech pathologist, a physical therapist, the college's Director of Supportive Services for the Disabled and Janie's family, decided upon a course of action: Janie would be provided with access technology which gave her maximum use of personal computers. The primary focus would be on word processing with extensive computer-assisted instruction programs used to upgrade her skill levels in the areas of reading, spelling and writing. With the possible exception of assistance required to turn on the computer, the system would be designed to allow Janie to use all of its options independently.

To accomplish these computer access goals, several major questions would need to be answered:

1. **How to access the computer keyboard given the limited control of head movement Janie possessed (enough to operate the Express III with the infrared optical pointer but not nearly enough to allow her to use a standard PC keyboard with a headstick or other pointing device)**
2. **How to design a "user friendly" computer interface which would provide full access to all programs and resources while continuing to make sense to someone with no previous exposure to computers**
3. **How to reduce the sheer volume of time Janie required to complete written assignments, carry on conversations and answer classroom questions**
4. **How to generate the funding with which to buy the equipment to solve the first three problems** 3.44

The funding issue was solved decisively and dramatically by a group of businessmen who became aware of the project and promptly raised $27,000 to provide Janie with whatever technology might be needed.

Selecting Appropriate Access Systems

Several keyboard access alternatives were considered (scanning systems, direct visual selection and special keyboards) before a decision was made. Extreme spasticity and rapid fatigue precluded the use of any kind of physical pointing system to access the keyboard. Eye gaze systems were impractical due to spasticity and pronounced nystagmus. Although she was capable of using a scanning, single switch system, Janie had a strong dislike of this approach and would not consider it as a possibility. Scanning would also have been much slower than Janie's present communication speed with the Express III. We determined to use Janie's Express III for computer access since it could also be made to function as a remote keyboard for the PC computer through use of the model K-II Keyboard Emulating Interface for the IBM PC from the Prentke Romich Company.

Since Janie was already proficient at using the Express III, it represented one less obstacle to overcome along the way to providing her with computer access. The reduction in speed of text production brought on by Janie's limited key selection accuracy and the mechanics of using the communication device could be offset through use of "smart" word processing software.

Designing Friendly Environments 3.45

With ease of use and timely production of accurate, written communication as primary goals, we began the second phase of the project: selection of software and design of the interface between Janie and the computer. For many profoundly disabled persons, the use of a computer is a "necessary evil." When designing special access methods for use by such individuals, it is vital to remember that the person using the system may or may not have any special interest in computers per se. Simplicity is absolutely essential. Janie was not inherently fascinated by computers nor particularly interested in the technology; she simply wanted a tool she could use independently which would allow her to write effectively and learn at her own pace.

Using an IBM PC XT with a 10 megabyte hard disk, we designed and programed (using simple commands in the IBM PC DOS batch file language) a sophisticated and yet easy-to-use, menu-driven interface which could be operated with single keystrokes. The main menu, which appeared automatically after the computer was turned on, provided three main options: word processing, word exercises and games. Selecting the word processing option displayed a secondary menu of word processing categories which Janie agreed seemed to cover most possibilities: homework, business, personal letters, communication or return to main menu. Selecting the word exercises option displayed a secondary menu of choices: Word Attack, Spell It, Speed Reader II (Davidson Associates software) or return to main menu. Selecting one of the word exercises options would display a third menu offering various grade levels at which to work. Choosing a grade level started the selected program using materials appropriate to that grade level. Each of the programs from Davidson Associates were similar in design and operation, thus reducing the learning time and simplifying the overall use of the computer assisted instruction programs. Upon exiting any of the selected programs (word processing, word exercises or games,) Janie was automatically returned to the previous menu. In this way, Janie would have independent access to all programs available on the computer system.

3.46 Selection of appropriate software is a critical process. It must meet the student's needs without becoming overwhelmingly complex and, in the case of severely disabled students, it must function harmoniously and concurrently with one or more hardware and/or software adaptations operating in the "background."

In order to enhance and extend Janie's ability to produce written and "spoken" text, we employed a new software technology which may hold tremendous potential for profoundly disabled students. "Smart" word processors such as MindReader from Brown Bag Software use techniques of artificial intelligence to examine the context of a sentence being written and "guess"—with amazing accuracy—the word or phrase about to be typed based on its initial one or two letters. For profoundly disabled individuals, such programs provide a significant increase in the speed at which text can be produced. Such programs also have the ability to learn the writer's style and selection of vocabulary so that as time goes by, a very real partnership is established between writer and software resulting in greatly increased productivity.

In order to expand Janie's ability to produce "spoken" communication, we included Freedom 1, a program often employed by blind computer users to read any or all of the screen display. Speech output was produced through DECtalk, a state-of-the-art speech synthesizer from Digital Equipment Corporation. In combination, these two components provided an easy method for Janie to "say" as much or as little of what she had written as she wished. Using a sophisticated speech synthesizer like DECtalk also made it possible to create a distinctly female, non-robotic, young woman's voice. Janie's ability to identify with her artificial voice greatly enhanced her willingness to communicate verbally and thus improve both her written and "spoken" communications skills.

Slight modifications (with the publisher's permission) were made to the computer assisted instruction programs (Word Attack, Spell It and Speed Reader II) from Davidson Associates so that they woutld function smoothly within the design interface.

Training was the final, and most important step in the process. Although Janie had been involved in every phase of the project's development, ultimately, its success would depend on her ability to learn and use it.

We divided Janie's training into small chunks of information which could be easily mastered. Initial trainings focused on accessing and using the word processor in simple and practical ways. Additional lessons included methods for reading the screen, printing, using the instructional software and games. With each training, she gained a sense of increasing competency and success. Several months were required to complete the entire process and advance Janie to the point at which she could begin to function independently. Training was also provided to Janie's parents and aides who would also operate and maintain the computer system.

The system works well. Janie uses it daily to complete class assignments, write letters to friends and communicate with people in her home environment. She has learned to operate all of the basic features of the computer and continues to develop and refine her
3.48 skills and abilities. Although Janie can now function much more competitively in the academic environment, it is only a beginning. Much remains to be done as unexpected and sometimes humorous problems continue to arise. Janie's enthusiasm for writing and learning have been such that her extended periods of using the Light Talker/computer interface have resulted in serious neck strain. Having acquired access to a device which greatly expanded her freedom of communication, Janie began to produce text in a volume sufficient to clearly demonstrate the extensive scope and range of her learning deficits. Adapted computer technology has provided an opportunity for a bright, highly motivated and remarkable young woman to reach beyond her disability and take a firm grip on the future.

We asked Janie to write about her life as a way of sharing her remarkable spirit with others. What she wrote seems a fitting conclusion to this study and ample justification for the importance of providing profoundly disabled students with access to adapted computer technology.

Janie

My name is Janie and i was born in Phoenix, Arizona the youngest of eight girls. But i got picked to have C.P. but somehow we did live thru it. For eight days the mds told my mom and dad that I would not live ut boy I did and people who knew me well just look and say Why me God. But I am happy that I did live because I have seven good sisters who would not let me think I have C.P. Where they went I went. When I was little I would be home plate for the ball games or I would be out fielder. They would tie my chair to their bikes and take me to the store with them. One time they were going on camp out to the Grand Canyon and I was on the floor watching them pack and my mom said no you cannot go. So they put my bag and clothes in car and said by mom and picked me up and I did go. I went on a river trip with my dad and y sister Kayla and Marilyn and her man. My dad did not go on trip but he did drive us up to the river. I rode on horses with my sister Kayla and we did jump barrels but my mom almost had a heart attack and said no no no. So we said ok mom and gave each other the wink and go ride some more.

My mom went to schools every year and asked if I could just sit in on class but they would say no we can not handle her so when I was four years old my mom took me to a cp school and they put me in room with just old lady and babies and pens and paper and gave me mush to eat. So I cried and after half day the school called my mom and said come and get this kid.

Every year when it was time for school to start my mom would go to the school near us and try to get them to just let me sit in the class when they were teaching reading but they would always say that I am retarded and they did not take retarded kids. So one day a Nun come to visit and she said if you do not think this kid is etarded I don't think she is so we will d out. So the sister andmy mom and dad took me to L.A. to Rancho LosAmigos and they tested me for two days and sent their report to us. It said I am little retarded. So my mom and jump up and down and took me back the next year for them to test me again. So they brought an "expert" up from SanDiego to test me. His report said this kid is of normal intelligence. So my mom took it back to the school and they said but it is a law that kids have to be potty trained to go to school. My mom sat on the floor and cried and my sister Cynde was going to Europe the next day and 3.50 she said "Janie, if you can tell us when all your soaps come on and what number they are on you can tell us when you have to go so I will give you 25 cents for every time you go to the john while I am gone. She still owes me money but the next time my mom went to school I was potty trained. I will do anything for money. Well; almost anything.

Now the school did not have any more excuses to not let me go so they sent me to a school name Gomper's Rehab. It was a ok school but it was not for me. I was not getting time to be taught and when the teacher sent home a good picture and said Janie did it all by herself and I can not use my hands my sister Kayla made me a sign and I did picket the teacher. Boy she was mad. But I did go to summer school and one day some teachers who were there to observe while working to get their masters and they did pick me to watch. When the day was ended they told my dad and me about Washington school because it had special classes for me. So I went there for the next three years. They were very happy years.I had the same aide for three years and she is one of my best friends today. At that school I learned to TYPE with my head and to use the Bliss symbol board which I did not like. Each year in May we went on a three day camp out. Half of the kids had never been away from home at night. It was a blast. My dad and Kayla went my sister worked with the kids but my Dad was food man My sister is now a Special ed. teacher.

To get money for our camp outs the kids sold tickets for a raffle. I got my bus driver to make an afghan and my sister Anne Marie took me all over our streets selling tickets. I did sell over $200.00 in tickets the most in the school and all people were shocked but not Pat the aide in my room, who is one of my good good friends today. She said thats my Janie. I did graduate and then I went to high school. It was o.k. but I had a man teacher and he did read the news paper for two years. He did talk the school to buy Express 2 but he got put in a new room. My sister Tricia was .T. at a school in L.A. for handicapped kids and the school had summer school so my sister asked the speech teacher for books on communication and she said no bring Janie to summer school. So I went for six weeks and that lady really knows her stuff. That is when I got my E-Tran. And she is still my friend today. One day my sister Marilyn called me from Phoenix and said Guess what Janie, you are going to have a new teacher and you met her when I worked with her at the Grand Canyon that summer. She did hurt me and that is all I want to say about her.

My mom and dad said they would find me a new school so that summer we went to see schools in south Ca. but we did not like it there so we came up here to see my sister Tricia who lives here now. We could not find any school here so we packed our bags to go home and give up. My mom is into old things so talked my dad into one more day so she could go to an auction.

I am not in to old things so why I did go I do not know. I was talking to my mom and my sister Tricia with my E-tran and a lady setting behind us was watching me for a long time. She asked us about the board and said I was a speech teacher at A.B. Ingham school and I know kids who could use a board like that. We went home and called the school and they were having summer school so we could come out to see it. My mom and dad and Tricia fell in love with the O.T. She showed us things she was making for the kids. I did wonder about her she just was too good to be true. I cannot spell too well and her name is Georgette so I just called Nuts. That is short for Nuts and Bolts because she always ran around with a little box of nuts and bolts fixing things. But in my book she will always be "My O.T." 3.52

And there was Verjean my speech therapist who I call Red. She is my eyes and ears and always looked for new things for me.It would be a book for me to tell about Jim and the staff and how much they did do for me and how much they mean to me.

Now I do believe in miracles and I did get mine when I went to that auction and ran into that lady. Because I did meet Nita, my teacher. I cannot I cannot say what she means to me. I was hurting in my ego really bad when I went to A.B. Inghamand I really did not want to go and Nita knew it because I did not want to live over here away from my other sisters. But I heard my dad say for 23 years Get high school diploma and I only had one more year in Arizona. But I did know I could not make it without going nuts so 'I did make up my mind to come over here. But Nita worked with my ego and. Boy, she did get it back in shape. It is running over now. She worked me really hard and told me you are coming to summer school so I said o.k. If I did say no she would say I am sorry Janie but you are. So I did. We did bring my grade level up in two years and six weeks. And I did graduate. Now i am going to M.P.C. and I got a B in my first class, Child Development. So I do think I will make it.

References

Barker, M.R. and A. M. Cook. (1981). A Systematic Approach to Evaluating Physical Ability for Control of Assistive Devices. Proceedings of the Fourth Annual Conference on Rehabilitation Engineering. Washington, D.C.

Brandenburg, S.A. and G.C. Vanderheiden. (1987). Rehab/Education Technology ResourceBook Series: Communication, Control, and Computer Access for Disabled and Elderly Individuals. Boston: College-Hill Press.

Weiss, L. (1983). "An Improved Row/Column Scanning System, TETRAscan II." Zygo Industries, Inc., PO Box 1008, Portland, OR 97207

Access Requirements for Persons with Learning Disabilities

About Adaptations for Learning Disabilities

Approximately three percent of any given population experiences mild visual, auditory or tactile-kinesthetic processing deficits of a neurological origin. Within the context of the K-12 and post-secondary educational environments, the subtle and complex effects of these deficits on a student's ability to acquire, integrate, and express information are referred to as learning disabilities. Although this disabling condition has presumably been a consistently occurring part of our population, it is only in recent years that sophisticated testing methodologies have been developed which accurately identify the range and scope of these deficits and their impact on the learning process. Adapted computer technology can be strikingly effective for individuals with learning disabilities.

A visual processing deficit frequently manifests itself as a chronic, intermittent inability to receive and/or express written information in an organized and sequential manner. For a student in post-secondary education or an employee in a text oriented occupation (i.e., word processing) setting, the effects of this disability can be devastating. Using a combination of adaptations including smart word processors, real-time spell checkers, screen reading systems and advanced speech synthesizers, an adapted writing environment can be created which is multisensory rather than visually oriented. In this environment, spelling can be checked and corrected continuously and automatically, "smart" word processors suggest likely word or phrase choices and the user can hear what he/she has written. The process of identifying and correcting errors in grammar and sentence structure can proceed unobstructed by the effects of the visual processing disability.

Individuals with auditory processing deficits experience a significant, intermittent, inability to receive, discriminate, retrieve, retain, sequence, and/or associate relevant auditory information. The visually oriented nature of a computer display allows such individuals to utilize computer assisted instruction (CAI) as a powerful adjunct to speech based classroom lecture formats.

Tactile and kinesthetic processing deficits often involve a significant inability in one or more of the following areas: fine and/or gross motor tasks, rhythmical movement and/or orientation to time and space. The effects of such deficits are often seen as an inability to write legibly or place text accurately along a ruled line. Visual/spatial orientation problems can make it difficult to read columns of numbers or remember the location of text on a page. Using the computer keyboard to produce text rather than paper and pencil can reduce
4.2 many of these difficulties. Word processors automatically control the orientation of text on a page and provide a variety of methods for locating text or reading columns of numbers.

A learning disability may be the result of a single processing deficit or of the complex interactions of multiple processing deficits. There are no simplistic solutions to this disabling condition. The issue being addressed is not so much adapted access to the computer per se, but rather how to use the computer as a dynamic medium for the production of written materials and the identification and correction of syntactical errors resulting from the effects of processing deficits and utilization of computer assisted instruction as an aid to strengthen and reinforce basic skills.

Individuals with significant processing deficits might require the use of one or more of the following adaptations:

- **A clearly structured word processing system**

  Word processing systems to be used by learning disabled individuals should incorporate a minimum number of commands, make good use of function keys and utilize well formatted, uncluttered screen displays. In addition, the word processor should be accessible to "real time" spell checkers as well as screen reading programs; it should also produce output which can be examined by grammar and usage checking programs. Using such a system, the student should, with instructor assistance, be able to produce a written document within an hour and comfortably use the basics of the system within two to four weeks. For many learning disabled students, the icon-based environment of the Macintosh computer may be significantly easier to learn and use than the more text- and command-oriented systems found on PC-type computers.

- **A "real time" spelling checker**

  Students with visual processing deficits frequently experience severe difficulty with spelling. A "real time" spell checker monitors spelling as words are actually being typed. The moment a spelling error is detected, a tone sounds. Pressing a single key displays a list of probable words. Pressing an additional key carries out the spelling correction. It is most important that the spell checker base its display of likely words on sound alike (phonetically spelled) words rather than attempt to closely match actual spelling. A well designed spell checker should, for example, suggest "psychologist" as the correct spelling of "sickologest." Ideally the spell checker should handle common letter reversals and maintain the correct verb tense

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when correcting a word. Additionally, the spell checker should provide a definition of the word in question along with its grammatic form (verb, noun, adjective, etc).

- **A screen reading system**

Individuals with moderate to severe visual processing deficits can benefit substantially from many of the adaptations employed by blind computer users. Use of a screen reading system and sophisiticated speech synthesizer in combination with a word processor and "real time" spell checker allows for the creation of a writing environment in which the error identification and correction process is carried out through auditory feedback in conjunction with the screen display. When text is reviewed auditorially, the impact of the visual processing deficit is minimized, and errors which might have gone undetected are easily identified and corrected. Screen reading systems employed for this purpose should be capable of reading letters, words, lines, sentences, screen pages or complete documents and of making maximum use of the speech output capabilities of the attached speech synthesizer. It is highly recommended that only sophisticated speech synthesizers capable of producing easily understood, naturally inflected speech be employed for this purpose. To inflict the burden of having to decode the robotic utterances of less sophisticated speech synthesizers would substantially reduce the utility of such a system. For additional information on screen reading systems and speech synthesizers, refer to the chapter of this manual dedicated to adaptations for blind computer users.

- **A "smart" word processing environment**

For individuals with severe visual processing deficits, "smart" word processing systems used in conjunction with "real time" spell checkers and screen readers attached to sophisticated speech synthesizers may be very effective.

Smart word processors employ the newly emerging technology of artificial intelligence to make amazingly accurate predictions about word choice while a sentence is actually being written. Using a predictive rule base about how the English language works, word frequency patterns and a history of the user's word choice preferences, such systems can very accurately predict the completion of a word being written based on its first two or three letters. The user is shown a list of likely choices and may elect to complete the word or phrase by pressing a single key. Such systems
4.6 also automatically manage such tasks as inserting the correct number of spaces after periods and other punctuation marks and beginning each new sentence with a capital letter. Additional options allow the user to insert commonly used phrases, add header and signature blocks to letters or modify verb tense. The utility of such a program becomes apparent when used with individuals whose processing deficits are so severe as to make errors in virtually every word produced. The interventions provided by smart word processors can dramatically reduce the incidence of error and therefore speed up the writing process.

- **A method for review and correction of faulty sentence structure**

Once a document has been written using a word processor, programs exist which are capable of performing a rigorous analysis of usage and style. Although still somewhat in their technological infancy, such programs are capable of pointing out a wide variety of grammatical, usage and style errors. Run-on sentences, vague terms, missing punctuation marks, sexist terminology and awkward word choices are all within the scope of problem areas which can be identified. As another tool in the error identification/correction process, grammar and usage checkers can be extremely valuable.

- **Methods for modifying color and size of text display**

  In some instances, modifying the size of text displayed on the computer screen, changing the color in which text is displayed or the background color upon which text is displayed can have a beneficial effect on the learning disabled student's ability to accurately read the screen display. For additional information on large print displays, please refer to the chapter on adaptations for low vision computer users. Many word processors, spell checkers and grammar/usage programs provide built-in options which allow the user to change the text display and/or background colors. If such options are not available within the program, they can be performed using very simple commands within the computer's operating system.

- **Alternative methods for issuing word processing commands**

  Individuals whose processing deficits result in difficulty remembering abstract information and/or sequencing instructions may have difficulty utilizing the complex command structures of some programs. Alternative command selection methods exist which can greatly reduce these problems. Programmable, touch-sensitive tablets can be employed. Commands can be stored at various locations on the tablet's surface and color coded or labeled in other ways which are meaningful to the student. To carry out a particular word processing or spell check command, the student simply touches the correct location on the tablet. In an attempt to simplify access to the computer in general, many new systems are incorporating icon based programs in which commands are replaced by symbols that can be selected using a mouse or other pointing device. Such symbol oriented systems may prove much more accommodating to individuals who experience substantial difficulty remembering, sequencing or manipulating abstract commands.

4.8 Providing a functional computer environment for a learning disabled student requires a thorough understanding of the scope and extent of the processing deficits involved. Once this has been accomplished, a wealth of opportunities can be provided using a variety of readily available programs. Many of the difficulties experienced as a result of some types of processing deficits are reduced simply because of the nature of the computer itself. The liabilities of an auditory processing deficit are reduced when information is gathered through a text oriented computer display. The difficulties experienced by an individual with tactile and/or kinesthetic deficits in the production of handwritten text do not occur in a computerized word processing system. As of this writing, excellent software exists for IBM PC, PC compatible, Apple Macintosh computers and, with the exception of large print systems, for the Apple IIe as well.

Word Processing Strategies for the Learning Disabled

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In order to facilitate the mastery of word processing on the microcomputer by adult, learning disabled students, a number of learning strategies can be utilized. Several general strategies are presented which relate to the basic process of teaching learning disabled individuals as well as a variety of specific strategies which relate to the step-by-step teaching of word processing. To understand these specific strategies, it is necessary to identify what students have to know in order to operate the word processing program and, within this context, to explore how the student best learns and retains this material so that he or she can successfully apply this new information to written assignments.

Ten general strategies facilitate overall understanding of word processing. They are presented in boldface print. Underlying each of these strategies is the core concept of "chunking" information into small, more easily assimilated units of information.

It is vitally important to use a **multisensory approach** which stresses hands-on work at individual microcomputers. Students should be encouraged to sub-vocalize information from the screen as an aid to error location; they should also be encouraged to sub-vocalize the steps necessary to write, edit, save, and print.

All the strategies discussed here are best applied in small groups of six to ten students. Smaller class sizes and individualized instruction tend to reduce the effects of distractability, a frequent consequence of the neurologically based cognitive processing deficits common to many learning disabled persons. The instructor should also include frequent **repetition** of the necessary sequences to enter, edit, save, print, etc. The student should make use of lab hours to work by himself and record successes and problems which occur during such lab sessions.

When the student gets "stuck," the instructor should **model** the question(s) necessary to resolve the problem. For example, "How do I move a block of text? First I, etc." Be specific to whatever program and microcomputer are being used. Build into the daily lessons **brief reviews of the concepts** covered. These reviews could take the form of questions or demonstrations either for the group or an individual. Provide short tests of the concepts, and review the answers with the students before moving to the next lesson. Ask the *4.10* student to **demonstrate** the various commands he/she needs to complete his/her list, letter, paragraph or essay.

For any task requiring sequencing, ask the student to **visualize** the steps he or she needs to follow in order to initiate and complete the command. Recommend that, in his mind's eye, the student see himself turning on the computer, putting the software in the correct drive, starting the word processing program, etc. If the student is unclear about any one of the steps in the process, he or she should refer to a quick reference card or ask the instructor for clarification.

Side by side instruction with the teacher or another student who has mastered the concept is preferable to physically standing over or behind the student. Work individually with students as much as possible. A self-paced format is best.

A typing speed of 15 to 20 words per minute is necessary to produce written material in a reasonable amount of time. For students not currently typing at that rate, computerized typing tutor programs can be employed to help increase typing speed.

An unhurried approach, with time for questions and individual help, is an essential strategy. Maintaining a **checklist** of concepts mastered by each student can help the instructor individualize training so that each student moves at a comfortable pace.

In order to use a word processor, the student must understand five pieces of information. These pieces can be broken down into easily understood "chunks" of information. To master each of these information "chunks," specific learning strategies are employed. Each of these strategies is presented in boldface print.

Overview

Discuss what a microcomputer is and how it can help students with writing projects. The difference between a typewriter and a microcomputer word processing program should be covered. Malfunctions of computer hardware and software should be explained. An important strategy to employ at this point is to encourage the student to identify specific projects for which he or she could use the word processor. Such projects might include to-do lists, letters, short paragraphs, essays or any written assignments. *4.11*

Initiate class discussions concerning what a word processor program will not do. For example, it will not automatically turn out well-organized material, nor will it conceal the need for original research or knowledge of the subject.

The instructor should define basic technical terms such as wrap around, window, microcomputer, hardware, word processing program, software, boot disk, program disk, disk swapping, drives, file, keystroke, icon, document and screen in understandable language.

A written and illustrated **syllabus** documenting each lesson presented is essential for learning disabled students. The language used should be concise and easily understood with room on each page for notes and questions. **Present only the amount of information needed** to succeed at the defined task. Whenever possible, a numerical list of basic sequences should be given. Use color graphics to highlight various sequences. It is helpful for the student to have a personal file disk formatted by the instructor with the syllabus lessons copied on it, so he can put lessons on the screen as well as have them in written form.

Operation

4.12 The student should understand the basic operation of the word processor. Information concerning disk drives, memory, on/off and monitor switches, power supply, printer, and handling of software should be presented. From this point on, the strategy to use is hands-on operation, so that the student controls his or her own input and output. Also, at this point, sequence becomes very important. An effective strategy is to list the steps needed to begin writing. On a plasticized reference card, place information appropriate to the specific word processing program you are using. For example:

1. **Place the word processing disk in drive A:**
2. **Place the file disk in drive B:**
3. **Turn on the computer**
4. **Type WP and press the ENTER key, etc.**

To simplify the above sequence, some microcomputers can use color coded keys such as the escape key and other command keys. After developing a sequence such as that listed above, the instructor should ask a representative student to attempt to use the sequence without prompting. In this manner, the instructor can identify gaps in information, and confusing or unclear presentations.

Entry of Text

As soon as possible the student should be encouraged to enter his own text based on the objectives he/she and the instructor have previously defined. If the student is writing at the paragraph level, a prewriting exercise is workable. Demonstrate techniques for preliminary writing such as mindmapping (quickly 4.14 recorded thoughts and ideas about a particular subject) or more structured outlining. With some microcomputers it is possible to enter a topic in the center of the screen and then use graphics to circle or box it. Supporting details can be entered in a wheel shape around the topic. Other appropriate prewriting techniques can be adapted to the particular microcomputer used.

At this stage, the mindmap or outline can be saved to a personal file disk and printed to paper so that the student can refer to it as he/she begins using these ideas to build sentences. Include on the first page of the reference card the necessary steps to save the document to a personal file disk; also include the basic print commands. As with the operational commands, list these steps in numerical order. Initially, the student's personal file disk should be formatted (prepared for data storage) by the instructor. After the student has mastered the basics of word processing, information about formatting disks and copying files can be presented.

Encourage the student to enter text without checking for errors when writing the first draft.

Editing of Text

At this point in the writing process, strategies should be directed towards having the student review the text for mechanical errors, complete sentences and coherent structure. Introduction of spelling verification, screen reading and grammatical programs should occur here. Again, numerical sequencing of the steps necessary to complete these processes is very important. On the second page of the plasticized reference card, list the frequently used editing, spell checking or screen reading commands. Editing terms such as replace, delete, move and find should be introduced and the sequence for using these commands listed.

Printing

Introduce necessary options such as spacing, margins, centering, justifying, unjustifying, and defaults. As with the above command sequences, introduce terms in simple language and **only provide information on the necessary options** to complete the assignment. For example, if specific margins or centered titles are not necessary for the completion of a specific assignment, do not present them. Print and page formatting commands can be listed on the third page of the reference card.

Word processing using a microcomputer is a useful tool which can be effectively employed to enhance the adult learning disabled student's writing ability and logical thinking processes. The application of the general and specific learning strategies described here will help the student master and use this valuable information.

Access Requirements for Persons with Other Disabilities

Adaptations for Other Disability Groups

Adapted computer technology can benefit individuals whose disabilities are other than visual, orthopedic or learning. Persons who are deaf or hard-of-hearing or have acquired traumatic brain injury can also profit from access to some components of adapted computer technology. In many instances, the benefits will be in the form of access to the computer as a dynamic tool for building or strengthening basic skills, producing written materials more efficiently or assistance with learning new information.

Deaf and Hard-of-Hearing

The processes by which we acquire and use spoken or written language are subtle and complex. Learning to produce spoken language requires, among other things, the intricate interplay of auditory memory (remembering how a word sounds), motoric/kinesthetic memory (remembering how to shape the lips, position the tongue and manipulate the breath in order to produce the spoken word) and pragmatic/word usage memory (remembering how to arrange words in ways that correspond to currently understood word usage patterns). Spoken or written language and hearing are intimately bound to one another. The process of acquiring spoken language is largely dependent upon continuous auditory feedback. The learner dynamically compares his/her word pronunciation with an auditory memory of how the word is "supposed" to sound. Continuous motoric/kinesthetic corrections are made to speech production until the spoken word matches auditory memory. Over time, the developing individual learns to communicate his/her needs, feelings or thoughts by assembling groups of words in ways which

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are meaningful to others. Ultimately, the user of spoken language gains mastery over an extraordinary array of sounds which allow the individual to communicate the full, subtle and intricate spectrum of human thought and emotion. Acquisition of written language follows the development of spoken language. Because successful use of written language is profoundly connected to spoken language, individuals who for one reason or another experience difficulty with the acquisition of spoken language will often experience difficulty perfecting the use of written language. Listening to the way language sounds is one of the primary ways in which we learn to develop and refine "correct" grammatical usage of written language. We both shape and are shaped by our use of spoken and written language. We use language to organize and codify our thoughts. It is the tool by which the abstract is made concrete. And this entire intricate structure of communication, conceptualization, organization and interaction is based, fundamentally, on our ability to hear.

For congenitally deaf or hard-of-hearing persons, this critical ability is absent or seriously impaired. As a consequence, they frequently experience great difficulty acquiring and using written or spoken language. There is often, however, very little real correlation between a deaf or hard-of-hearing person's innate intellectual capacity and his or her ability to use spoken or written language. Acquisition of vocabulary is largely accomplished through use of auditory memory. Deaf persons who must depend entirely on visual memory (how the written word looks), typically have significantly smaller spoken or written vocabularies than hearing individuals. Absence of spoken and written language as the primary method of communication can also have an effect on the congenitally deaf or hard-of-hearing person's ability to shape, formulate and express abstract concepts. For deaf or hard-of-hearing individuals with basic writing skills, production of written language can often be assisted through use of the following adaptive interventions:

- **Visual cueing of auditory prompts**

  Since many computer programs make use of various tones, chirps and beeps to alert the user to error conditions, work completion or other events, it is vitally important that deaf or hard-of-hearing persons have access to these cues. The system should provide a visual, on-screen prompt (screen flash, icon or other symbol) to notify the hearing-impaired user of these events.

- **Conventional or "smart" word processing systems**

  5.4 Word processors provide a structured environment for the production of written materials. The ease with which grammatical, structural or spelling errors can be corrected is unmatched by any other writing method. "Smart" word processors have the added capability of suggesting likely word choices as a sentence is being written. This can be invaluable to deaf students who experience difficulty with word recollection. The ability of "smart" word processors to append suffixes, pluralize words, provide automatic spacing after punctuation marks and automatic capitalization of new sentences is an additional aid.

- **On-line spell checking programs**

  Phonetically based spell check and correction programs are vitally important to providing productive writing environments for deaf or hard-of-hearing individuals. Spell checkers should be easy to use and continuously available (on-line). Ideally, they should be integrated with the word processor and no more than a keystroke or two away. When correcting a spelling error, such programs should display the misspelled word along with the sentence in which it was used, suggest the correct spelling, provide a definition of the correctly spelled word and perform the correction automatically.

- **On-line thesaurus programs**

  Continuously available thesaurus programs can be invaluable aids to augmenting limited vocabularies and suggesting new directions for self-expression. Ideally, such thesauruses should provide a definition of each available synonym, maintain correct verb tense and perform word replacement automatically.

- **A method for review and correction of faulty sentence structure**

  Once a document has been written using a word processor, programs exist which are capable of performing a rigorous analysis of usage and style. Although still somewhat in their technological infancy, such programs are capable of pointing out a wide variety of grammatical, usage and style errors. Run-on sentences, vague terms, missing punctuation marks, sexist terminology and awkward word choices are all within the scope of problem areas which can be identified. As another tool in the error identification/correction process, grammar and usage checkers can be extremely valuable.

- **Screen reading programs**

  For persons who are hard-of-hearing, easy-to-use screen reading programs combined with advanced speech synthesizers can be a great help in the production of written materials. Advanced speech synthesizers provide for hundreds of adjustments to speech output. In many instances, the synthesizer can be adjusted to produce spoken output at a volume and frequency which fall within the auditory range of a hard-of-hearing individual. Once this has been accomplished, the same types of screen reading systems and techniques which have proven successful for use by students with learning disabilities can be used by individuals who are hard-of-hearing. For additional information on screen reading systems, refer to the chapter in this book on adaptations for students with learning disabilities.

Adaptations for Persons with Acquired Traumatic Brain Injury

5.6 Individuals with acquired traumatic brain injuries (ABI), represent the fastest growing disability group in North America. Head injuries resulting from automobile, sport and industrial accidents account for a large percentage of this population. Such injuries can produce a wide range of effects including memory loss, disorientation, cognitive processing deficits and emotional disturbances. Although significant brain injury can result from seemingly minor accidents, advances in modern medicine now provide dramatically improved opportunities for surviving what would, until fairly recently, have been considered a fatal head injury.

In addition to the effects outlined in the previous paragraph, major head injuries can sometimes have additional consequences including loss of fine motor control and/or vision. For persons with ABI undergoing post-injury rehabilitation through the use of computer assisted basic skills instruction and special computer programs which help reestablish basic cognitive processes, adapted computer technology can help to remove barriers imposed by limited fine motor control or limited vision.

For additional information on the specific requirements for such adaptations, please refer to the chapters on providing adapted computer access for persons with orthopedic or visual disabilities.

Profile of a High-Tech Center Director

Who are the people who operate and direct High-Tech Centers for the Disabled? What are they like? What are their backgrounds, interests and aspirations? The following chapter eloquently describes the joys, challenges and satisfactions of one such program director as she acquired the skills which have made her an Adapted Computer Technologies specialist. This revised edition also contains a brief postscript written by the same High-Tech Center Specialist two years later.

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The concept of a High-Tech Center for the Disabled is new; it has evolved out of practical experience at Monterey Peninsula College over the last two-and-one-half years. This profile is being written in December, 1986. As you read the following narrative, please remember that I did not touch a computer until August, 1984, two-and-one-half years ago.

I am now able to coordinate this High-Tech Center, a computer center, because it is free of unnecessary technology. This is paradoxical because I am not a "computer person." I am a trained speech-language pathologist and also hold a B.A. in English literature. For eight years I was a full-time speech-language specialist at this college working primarily in the areas of language retraining and thinking skills development with adults having deficits arising from stroke or head injury.

My assignment expanded in August of 1984 and I began assisting the major author of this grant, Carl Brown, as lab instructor and classroom assistant in a beginning word processing class. At the conclusion of his first lecture to the original class, he left the classroom with the statement that I would be there for the next two hours to help the students with their initial lab assignment. I learned how to complete the assignment as I instructed the students! Such an outcome does not indicate unique computer talent, but rather reflects maturity, teaching experience, and a strong streak of curiosity. With great composure and a straight face, I led the students through this initial assignment. They never knew it was my very first time to touch a computer.

It's OK to Be a Computer Novice

6.2 My innocence with respect to computer technology cannot be stressed enough. Becoming familiar with computers and software is not the mystery a novice might imagine. Learning to use a computer is a very simple, straightforward task because a computer's basic nature is self-teaching.

Institutions wishing to start High-Tech Centers will benefit from training existing personnel. One of the major attributes of the program proposed in this model is that it is not difficult to begin from an instructional or an institutional perspective.

Learning to Become Familiar with Adapted Computer Technology

I learned adapted technology within the context of teaching. I think this is the way it should be, although it reflects a very curious paradox; since we think of teaching as an activity following study and mastery. Such prior mastery was not possible in this case.

I soon learned, however, that the students were not put off by my not always knowing what to do. My very visible learning process seemed to influence the students in a positive way. They had little sense of failure when they ran into problems, because they saw that exploration was a part of learning, especially in computer and software tasks. What I had to overcome was my conditioned inner belief that I was not competent to be instructing the students because I was so new to the technology.

As I learned to assist students in solving their computer problems, I remained a visible example of competent learning. Students soon came to understand their own "glitches" as a natural learning process, not as failures. I did not, and still do not, present a model of technological infallibility. I consider this a natural component of my role as director of the center.

For a professional specialist, proficiency and competency are the hallmarks of success within one's discipline. To operate on the very edge of what I knew went against all my training, for to function professionally at a level of emerging competency was unprofessional. And yet, because adapted computer technology is so profoundly important, many individuals who have rich years of teaching behind them will be asked to operate, initially, from just such a position. As I have developed the skills which I now use today on a daily basis in the High-Tech Center, I have come to understand the importance and rightness of this challenge. The richness of merging prior competencies with the presentation of the amazingly simple but versatile adapted technologies is truly a creative synthesis.

Why am I stressing these deeply personal observations in an otherwise technically-oriented manual? Because some people tend to think of computers as dehumanizing. Within the context of a High-Tech Center, they are, in fact, humanizing forces. There is, as yet, no organized discipline known as "Adapted Computer Technology," but it is an area of great importance to disabled populations, and it will need trained specialists in the very near future. My personal experience suggests that seasoned professionals who are not yet computer users will be excellent and appropriate candidates for this new specialty area, for they will bring the richness of their years of teaching experience. I cannot emphasize enough the fact that experienced teachers of the disabled should seriously consider making the transition to computers via the field of adapted computer technology. To do so is a manageable and deeply rewarding learning experience. The benefits are two-fold: professional and personal. Not only does one develop the skills which are now needed to participate directly in the rapidly changing field of education, but one may also discover the increased proficiency which computer use may bring into one's own personal life. 6.4

Developing a New Model of Professional Performance

The special education instructor who is not yet computer-literate must not be afraid to adopt a new model of professional performance. Whereas I had always taught from a premise of subject mastery as the result of professional training, now I learned to teach from another perspective. I focus on the new skills and insights I am discovering, rather than on what I do not know. As a professional, I am used to operating from consistent proficiency, but this is not possible when learning new skills and passing those skills on to others at virtually the same time. Therefore, if one is mindful not to judge self-performance on the basis of one's past experience of competence, much progress can be made.

In my own experience, once I had realized I was judging each day from a perspective which evaluated not knowing as evidence of failure, I consciously restructured my belief system. In the past, an area of unknowing indicated to me a need for further study. Initially, in my new role as High-Tech Center instructor, to fill the void with a sense of completeness was impossible, since there was so much I did not know.

I restrained my professional responses to stuff information into this seemingly vast gap. I resisted the impulse to identify with all that I did not know. Instead I daily tallied the new I had learned. Once the positive framework was in place, my learning process accelerated. I developed a new model of professional performance. The stress which I had daily experienced from dealing with the unknowns of "the partially known" disappeared. I still revel in the discovery of freedom in operating from the new and merging it with the familiar old of my training. *6.5*

Teaching Adapted Technology Applications to Disabled Students

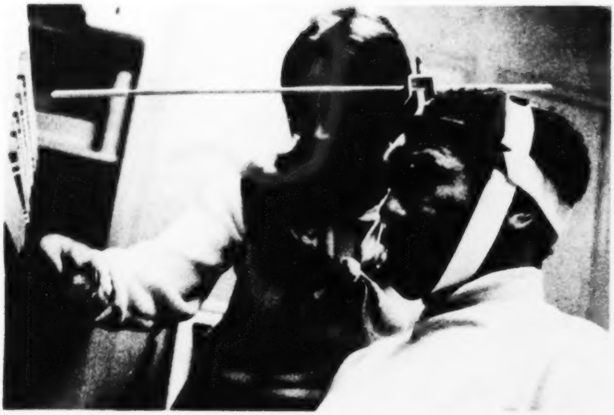
A Unitary Curriculum which Fosters Prescriptive Teaching

Computerized word processing using WordStar (although many other word processors might have worked as well) is the primary application through which the adaptive technologies used by the High-Tech Center are taught. In retrospect, this factor of a unitary curriculum was critical to my success as an instructor in the High-Tech Center. It meant that I had to become familiar with only one major program when I began teaching. As I became familiar with the program, I began to observe how students learned it. And it was at this point that I discovered a powerful attribute of this unitary curriculum: observing a student's use of WordStar became a diagnostic exercise. I began to see patterns of error emerge. I began to see responses to particular assignments as predictive of success or difficulty across a broad range of areas, as well as being indicative of access difficulties common to a particular disability group.

Observations were of two levels. (1) The process level: Could the student understand the way the word processor worked and what commands made it work? Did the student attend to the sequential screen activities? Did the student attend to screen prompts? (2) The language level: Was the student's writing fractured 6.6 with misspellings? Could the student express his/her thoughts? Could the student organize material?

By using one basic curriculum, there was a built-in standard of measure which gave the instructor an overview of how all students were functioning within the curriculum, although their disabilities and abilities might be very diverse. It was because of the consistency of the basic curriculum that student diversity stood out. Its uniformity highlighted their unique differences. And because these learning needs were so varied, so individualized, prescriptive teaching became the instructional method of choice. Basic information was presented in lecture form in a group class setting, and prescriptive techniques were individually applied during lab times.

Prescriptive teaching, in my case, drew upon a blend of prior training and past professional experiences. My particular training as a speech-language pathologist was of great relevance in the High-Tech



Center, for my strong background in assessment, diagnosis, and remediation of language deficits and my experience with retraining cognitive skills in the head-injured came into play on a daily basis. In fact, this strongly clinical background has deeply affected my instructional skills. It is a style of teaching that builds upon (1) direct observation of the student and (2) familiarity with his or her academic and/or medical history. With this information, and direct classroom observation of the student's response to the general class lecture, I am able to analyze how information should be presented to each student.

Many disabled students have no secondary learning problems and simply need access to adapted technology in order to achieve more efficient computer use. Other disabled students present a more complicated picture and have learning problems which directly affect the ways in which information needs to
6.8 be presented. Because of my background, I was able to perceive which learning problems were due to learning disabilities, which were due to language deficits, which were direct correlates of head injury, which were due to neurological disease and which may have been due to academic neglect or inadequate instruction in the K–12 system. In order for these students to learn the concepts of word processing, the same information was presented in a variety of ways: e.g., printed cue cards; visual reminders through color-coding of print material or keys on keyboard; oral questioning to elicit understanding of process; instructor modeling of computer activity.

Basic Disability Groups

Perhaps the best way to understand the nature of this instructional method, as it has evolved in the

High-Tech Center at Monterey Peninsula College, is to present brief sketches of typical groups of disabled students, their special instructional needs and the methods used with each. In reading these examples, please bear in mind that they represent disability groups served in the first years of the High-Tech Center and are in no way intended to place boundaries or constraints on the process of developing new and better instructional methodologies.

Student #1. Sally becomes confused with written directions and does not easily follow oral directions. She is quickly lost and confused. She watches passively as other students work at the keyboard.

This student is led through early tasks on a modeling basis. She is shown the computer command or action and is shown what happens as the result of this action. Then the student performs the action. If the student does not understand at this point, the action is demonstrated again and the student is requested to repeat her attempt. When this student memorizes the sequence of actions necessary to do basic operations, she then begins to understand the basic processes involved in word processing. This student also quickly understands the logic (such as it is!) behind the physical layout of the computer keyboard. Once the basic physical movement patterns necessary to affect computer action have been mastered, this student easily understands what she is doing and becomes a highly efficient user. Without prescriptive teaching, such a student would most probably not have mastered word processing if the major presentation of information continued to be oral or written. Modeling has made the learning task explicit.

Student #2. Although Bob grasps the basic tasks which he must do in order to get the word processor functioning, he has difficulty remembering the keystroke sequences necessary to complete processes.

An effective means of working with this student is to anchor him in a strong sense of process and structure. For some, explanations must be concrete; for others, more figurative. The nature of the analogy is critical, for it is the element which integrates the student's understanding of process. Once the sequence of process for a new word processing task is intact, the student then has the tools to utilize onscreen help. The fact that WordStar help is organized by category is helpful to this student. This student usually needs visual help from the screen on a regular basis to complete the sequence of keystroke commands to perform an action. Because the student understands the processes and purposes of WordStar functions, he can easily use the categorically arranged help menus.

6.10 **Student #3.** Gary has significant spelling problems. Writing, other than copying exercises, produces great anxiety. Although developing computer skills is not a problem, Gary is "language bound" and sits for long periods of time at a relatively blank computer screen.

The key for such students is simply to begin writing. In this instance, the nature and content of the writing assignment is critical. For some students it must be an affective assignment, one in which they will forget they are writing as they "talk" (through the keyboard) about something emotionally meaningful to them. For other students, the assignment must be objective so that there is no sense of personal association with the text. The student's desire to use the computer as a typewriter will overcome his/her past experiences of failure with writing.

Regardless of which pattern these students exhibit, they undergo a similar process of discovering freedom and power in the written word through the use of the on-line spelling checker and thesaurus which are always used in tandem with word processing. In the past these students have felt no pleasure in expressing thoughts in writing. In using the computer, they come to discover that they can produce text which is not riddled with serious spelling errors. Watching these students discover their latent abilities to express thoughts in written form is one of the very strong rewards of teaching in the High-Tech Center. Learning disabled students with mild-to-moderate spelling problems are a population who soon function on the computer with almost no sign of disability. The students are able to focus on content and organizational skills rather than on compensating for their poor spelling skills. The principle of using an on-line spelling checker is of paramount importance to these students.

Student #4. Eric is a low vision, legally blind student who has never written assignments. In high school he always took exams orally, if at all. He types well but has not used the skill because he could not efficiently read what he produced on a typewriter. His spelling is phonetic and inaccurate. 6.11

Such students may have very limited skills with written language. Attempts at written expression may at first be thought clusters or sentence fragments, rather than complete sentences, although the student can usually determine if a sentence is complete when he reads it aloud.

Because the High-Tech Center at Monterey Peninsula College is located adjacent to the English Center, where students work on an individualized basis, such students as Eric are often referred there for extensive classwork to build basic academic skills. The High-Tech Center staff works closely with English Center instructors to monitor academic progress. Additional tasks are assigned to enhance visual monitoring of text and spelling. Typically, such students are not used to looking at words or punctuation, as neither has been seen with any clarity. The large print display capacity of the computer and the ability of the student to use the thesaurus and spelling checker are a powerful combination for such students. Although years of listening to words via books on tape may have allowed these students to develop strong auditory skills, because of the emphasis on the aural input and oral output, the student never developed expressive writing skills. (Such students in the High-Tech Center have compensated for years of instructional neglect in only five semesters.) These students, like many students with visual problems, are used to gaining information aurally. These students should be encouraged to ask questions to elicit information; listening may well be their strongest modality. At the same time, it is critical 6.12 to train such students to become visual editors as they may not be used to using their eyes for detail work.

Student #5. Lyn is a non-sighted student who had low vision until she was 18. She has not learned braille well and does not use it. Her spelling skills are poor because she says she cannot remember what the words look like. Assumptions that this person would soon improve her spelling skills, as the result of working on the computer using screen reading programs and an advanced speech synthesizer, proved to be incorrect. Instead, her spelling seemed to deteriorate, and she became frustrated with learning to use the computer. It was not unusual for her to spend an hour correcting spelling errors in a paper she was to hand in for a transfer level English course.

Such a student would be referred to an on-campus remedial spelling program which emphasized an auditory and kinesthetic means of determining how to spell words (Auditory Discrimination in Depth [ADD Program] by Charles and Patricia Lindamood). In many instances, students with little ability to sound out words come to rely heavily on remembering a visual image of correctly spelled words. With the loss of vision, these students also lose their strongest method of compensating for this auditory disability, and thus spelling skills deteriorate. Such students often experience dramatically improved spelling capability and a consequential increase in word processing proficiency. Effective word processing is not possible for these students until their spelling skills improve.

Student #6. Melanie is a learning disabled student with mild written language deficits arising from a traumatic head injury she suffered as an older child. A common error pattern includes the omission of verb inflections and/or plural markers on nouns.

Such students are encouraged to use the screen reading programs used by blind students. As they listen to what they have written, errors in verb inflection and pluralization are easily identified and corrected. Semantic confusions not visually discerned also can be corrected through listening (e.g., the difference between intend and attend will be noticeable). *6.13*

Student #7. Kelly is quadriplegic as the result of an automobile accident. He uses a headstick to access the keyboard.

In spite of the severity of such a disability, this student is not at a disadvantage except for the length of time taken up by single stroke access to the keyboard. Although proper keyboard positioning is critical, no special instruction is necessary beyond training in the use of two software programs: (1) a small program which latches/unlatches the Shift, Alt and Ctrl keys and (2) a "smart" word processing pro-

gram which reduces the number of keystrokes it takes to spell common words. Such students often have good written language skills and relative ease of computer access within the context of their particular disability. Consequently, they are often more proficient at the computer than many students with seemingly less severe limitations.

Student #8. Anna is a college graduate; she has multiple sclerosis and is affected by memory problems as well as muscular incoordination. She is still able to type—with one hand and with difficulty.

Meeting the physical keyboard access needs of such a student is straightforward. Correct keyboard position is established, a programmable, touch sensitive keypad is used to facilitate command entry; and a software program which disables the automatic key repeat function of the IBM keyboard is employed to eliminate unwanted key strokes arising from muscular incoordination. The critical issue is the presentation of information at a pace such students can absorb. The neurological dysfunction created by these types of disabling conditions can be circumvented if small amounts of information are presented when the student is ready to receive them. Too much information presented at any one time will often result in an instant sense of overload with the student being unable to perform, retain or remember. Rather than moving the learning process along at some preconceived rate, it is more productive to allow such students time to work with each small unit of information until they have mastered it to their own satisfaction. When that point has been reached, such students will then ask for more information.

Student #9. Paul has a congenital, severe-to-profound hearing loss. His first language is American

Sign Language, but he is now working to develop improved written language skills by taking regular English classes and working with the Coordinator of the Deaf in special language development exercises.

Deaf and hard-of-hearing students frequently learn to operate the word processing system very rapidly and efficiently. However, their use of ASL syntax in the production of written language frequently results in text which does not convey meaning the writer intends. This inability to effectively manipulate the English language is a common problem among deaf students. Care must be taken in making sure that deaf students do not believe that a word processor will magically transform their writing to standard English. It is important that deaf students understand that although spelling errors can be corrected, they are responsible for sentence structure. Such an understanding will prevent significant levels of disappointment in
6.16 deaf and hard-of-hearing students.

A finger spelling program is used which incorporates the vocabulary lists being studied by deaf and hard-of-hearing students in the English Center. Visually tracking as well as manually shadowing the finger spelling of words seem to allow such students to internalize all the reading and writing they have done in vocabulary exercise books. A word is no longer a two-dimensional orthographic image (a visual string of letters) but a symbolic representation of a concept which is somehow internalized through tracking and shadowing the act of finger spelling.

This narrative description of typical students served by the High-Tech Center illustrates the extremely varied nature of the instructional environment. Use of a unitary curriculum in these classes allows for prescriptive teaching to be implemented. What has not been adequately addressed so far in this chapter is the apparent cumulative effect of immediacy in the learning environment.

Effectiveness of Teaching: The Effect of Immediacy

In computer use, every action receives feedback. An action is either correct or incorrect, and the computer patiently repeats its needs over and over until the process or procedure has been done correctly. When students write, they receive instant feedback regarding their spelling. When a word is incorrect, the computer beeps just after the student has entered the word. A list of likely correct spellings of the target word are displayed. The student presses a single key to have the word corrected and watches the incorrect spelling vanish and the correctly spelled word appear. In addition to this mechanical on-line support and feedback from the computer, students in the High-Tech Center also receive instant on-line instructional assistance from staff. Perhaps it is the extraordinary level of instant feedback from all sources which lies behind the apparent ability of a High-Tech Center to accelerate and facilitate student performance in addition to providing a means for computer access.

The High-Tech Center provides an extremely sound educational environment for disabled students to learn the adapted technologies necessary for them to succeed in computer use and, at the same time, provides a means for these students to receive instruction which facilitates their performance potential on many levels.

Running a High-Tech Center on an Everyday Basis

The High-Tech Center at Monterey Peninsula College is a working concept as well as a site. In order to illustrate this, I will first describe its actual physical setup, its staffing, curriculum and procedures. Then I will discuss the major concepts which underlie the operation of the center.

The Site

The center is located adjacent to the English Center in the Library building which is at the center of the campus. The fact that the center is located here is a philosophical choice; word processing is more related to English Center skills than it is to computer science classes. I believe that written language skills underlie success in any field of endeavor, and that the High-Tech Center can be a vehicle to implement, and most probably augment, those skills. As the students
6.18 learn the adapted technology each must use in order to achieve successful, barrier-free computer use, they also are developing more successful written communication skills.

Staffing

The Center has always been staffed by two instructors, one full-time and one part-time. When the center began in August of 1984, the instructors, Carl Brown and I, represented two different types of backgrounds: (1) computer science and educational computing experience and (2) English literature and speech-language pathology.

By the end of the first year, the concept of a High-Tech Center based on an educational, instructional emphasis rather than a technological one was intact. Except for the technological innovations which Carl Brown was working on or looking for, the center ran smoothly as an educational unit. The technology and curriculum were so sound and flexible that, once set up and implemented, they served to meet the varying needs of new students who enrolled in classes.

At the beginning of the second year we brought in a lab assistant who had experience as an interpreter for the deaf. This was an important addition, for it meant that there was someone who could efficiently communicate with the deaf students. In this way we could always be certain that the deaf students comprehended the assignments and completed their lab assignments with appropriate understanding. During the first year we observed that, although we thought a deaf student understood the nature of an assignment, the end product frequently was far different from what we had in mind. Once we had the interpreter as a lab assistant, deaf students began to spend more time on completing assignments and with this support system had the confidence to branch out into projects of their own.

Curriculum

Core Curriculum and Its Effect. The core curriculum of the High-Tech Center is word processing, which is taught within the framework of WordStar. This software was chosen for two reasons: it is an industry standard, and it works effectively with the many adaptations used by disabled students in the High-Tech Center.

The importance of using an industry-standard word processor cannot be overstressed. I have come to understand that the power and self-esteem which disabled students develop as they work in the High-

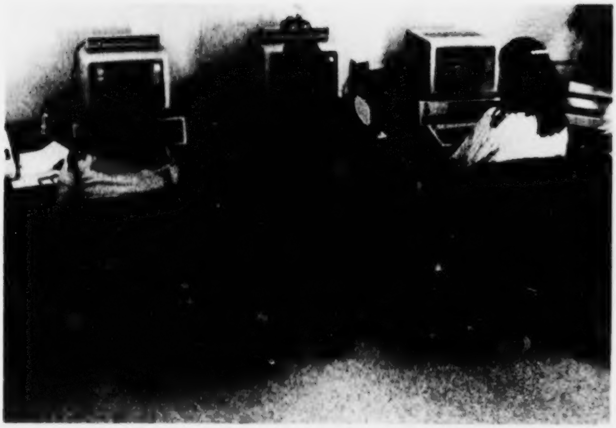
Tech Center stem in part from the fact that they can look in the help-wanted section of the newspaper and see exactly how useful and marketable their developing skills are. Students quickly come to understand the value of the word processing skills they are learning and often choose to upgrade their writing skills by taking classes in the English Center. The core curriculum—using an industry standard word processor—catalyzes students into seeing themselves as potential members of the working world.

As the students come to master the concepts of word processing, they are encouraged to bring in outside assignments to work on after completing High-Tech Center assignments. In this way students come to understand the efficiency which is inherent with effective computer use. Students with physical disabilities can work more effectively on a computer than on a typewriter; learning disabled students are able to *6.20* complete assignments which are free from spelling errors; and their efforts can be spent on content preparation rather than on spelling correction. I believe students acquire a heightened sense of self esteem as the result of gaining competency with a computer.

Class Scheduling and Lab Hours

The Center is open five days a week. Classes are held twice weekly for one hour. An additional one hour of lab time per week is also required. We use Tuesdays and Thursdays for classes and Monday, Wednesday and Friday for lab times. Courses are scheduled on the basis of curriculum rather than disability. The only exception to this is a beginning word processing class exclusively for blind students.

If there are multiple sections of one type of class, students are grouped on the basis of time needed to



complete an assignment, if possible. For example, an acquired brain injury student may take a long time mastering the processes of WordStar. Such students work well in a class with students who have severe physical limitations and are unable to produce text at a normal rate of speed.

Special Considerations

Beginning Blind Students. The unique needs
of these students require a special section because, in
addition to word processing, they must learn to listen
to and understand synthesized speech. The first session
for a blind student is simply to listen and to com-
prehend a short file on disk. At the next class session,
they review their listening comprehension and then
attempt to use the computer like a typewriter. For the
first two weeks we do all word processing commands
6.22 for them so they are not overwhelmed with two differ-
ent types of technology to master. After two weeks we
then begin to introduce beginning word processing
tasks.

Computer Use in Lab Times. A hierarchy of need is considered in determining computer use during lab time: some students (low vision, for example) must use the unit which houses their particular hardware adaptation. There are few hardware-specific adaptations in the lab, and the number of students requiring such adaptations is small. Sign-up for computers is done no more than one week ahead of time. If there is a valid emergency, and a student must use a specific computer, that student may temporarily preempt someone who is using the needed computer. This privilege is very seldom used. If two students have an emergency need at the same time, transfer-level work preempts basic skills class work.

The High-Tech Center as a Concept

For the first year of its existence, the High-Tech Center was a small classroom site. It was a place where I was learning the basics of how to interact with computers on a daily basis and teach from new knowledge rather than from previous patterns of training. It was also a place where Carl Brown was observing and correcting my difficulties with various hardware and software adaptations and also observing the still-unmet or poorly-met needs of disabled students who were enrolled in classes.

At the beginning of the second year, the High-Tech Center was much more than a classroom site. Carl Brown had come up with innovative technological solutions to the problems I had experienced in learning to teach the curriculum. The teaching process was simplified. The unmet student needs were no longer unmet as Carl found new, straightforward solutions. *6.23* As the second year proceeded, we soon discovered that the equipment and applications programs used in the Center were amazingly flexible in adapting to many different student needs. It became time to refine teaching methods and concentrate on improving the ways in which the courses were taught. What has evolved over time is a Center where real-life expectations are the rule. Standards are flexible but high.

A Real-Life Situation. In a sense, students who take classes in the High-Tech Center are in a work situation. We encourage them to solve assignment difficulties on their own. We offer the suggestion, "If someone were paying you to do this, what would you do?" Students call in if they are going to miss a lab session. (While there is no penalty for students who miss classes, the majority of the students take the center seriously and consider it a privilege to be working in it.) If students have an important outside assignment to complete and will need extra lab time, they are very efficient about sign-up or cancellation.

Because we require the ability to type as a prerequisite, some students work for a semester in a modified typing class offered in the Business Skills Center before they begin to take classes in the High-Tech Center. Other students (those who have an acquired brain injury, for example) have been working on the computers in the Learning Disability Lab. When brain-injured students demonstrate appropriate maturity and cognitive stability, they are referred to the beginning WordStar class. Students are excited to think they are ready to take the class, and they bring to it a genuine sense of commitment and achievement.

6.24 High-Tech Center courses are listed in the college catalog under "Special Education." Although many times it looks like a special education class because of the wheelchairs and headsticks and guide dogs, the center itself is really a center for "specialized" rather than "special education." Mainstream students use the lab as well. Computer assisted instruction is assigned by English Center instructors and a computer assisted writing class taught by a member of the English faculty meets in the center during lunch hours. During lab time, this mix of students is a good learning experience for all. Self-consciousness and stereotypes dissolve as students exchange assistance or share successes. This real-world orientation minimizes concepts of disability, just as computer use minimizes disability.

The High-Tech Center, then, is both a classroom and a concept. I view it as a place where, as a by-product of learning appropriate adapted technology and basic word processing skills, students experience a quality of action almost totally free from the effects of their disability. Their performance is maximized. I believe it is this concrete experience of success that must underlie the tremendous impact of the Center on the students. They soon come to understand they do not need to remain in the safety of the center for success; they have developed skills for success in the outside world. They have found an area in which they can function just like everybody else.

Postscript

The insights and experiences described in this narrative profile two years ago remain surprisingly valid. Nearly 200 professionals have been trained in the basics of the adapted technologies described. Most specialists who have been trained have received a copy of this narrative profile. Its content has proved helpful to many. As new High-Tech Centers evolve, the effectiveness of the small but flexible range of adapted technologies is proving to be a workable, functional introduction for specialists and students.

One understanding of major importance is emerging. Acquisition of written language skills is proving to be of great value in generating significant academic improvement in successful High-Tech Center students. The students who appear to make the most dramatic advances in academic progress are students who have not been able to use written language as a medium of expression. In the past, many disabled students have been denied effective use of written language because there was no technology to make writing easy and natural. Students with visual disabilities could not see well enough to comfortably produce written language and orthopedically impaired students could not efficiently produce written language. Therefore, access technologies successfully link students to computers and accessible computers create a new link to written language for disabled students.

Profiles of Disabled Persons Who Use Adapted Computer Technology

The disabled students who use adapted computer technology are as varied and diverse in their academic, social and personal goals and aspirations as any other student group on a college campus. Many are highly motivated individuals who have a clear vision of their future and advance resolutely towards it. Others move through academic life waiting for something to happen and wondering what they will do with the rest of their lives. As a group, however, disabled students who participate in high-tech center programs are enthusiastic (perhaps for the first time in their lives) about the possibility of successfully completing college, finding work and carrying on productive and enjoyable lives. The following profiles were written by disabled individuals who currently use computer adaptations as a part of their work environment or who are presently enrolled in a high tech center program. They are typical expressions of the excitement and enthusiasm experienced by disabled individuals discovering for the first time the freedom of access provided by these new adapted computer technologies. And more than that, they are the expressions of people who see a bright promising future.

Shannon

Before I came to the High-Tech Center at Monterey Peninsula College, the only computers I knew about were large, expensive (seven to ten thousand dollars) pieces of hardware with a screen reading program resident within. I was intrigued with these computers and thought that, with a little bit of work, I could learn how to use one efficiently. But what was the sense in thinking about it when they were so far out of my price range?

So, while I had little doubt as to my abilities when I enrolled in the High-Tech Center's section for blind students, I was rather cynical about one day being able to own my own system. However, when I discovered that my English 101 class required a total of eleven essays, I knew that the only way to complete that class satisfactorily, if not better, was the High-Tech Center and the ability to operate a computer. So, I put aside thoughts of whether or not I would ever have a computer of my own and concentrated on learning the word processing and screen reading programs so that I could get through my ever-present writing assignments.

Since I have a capacious memory, learning how to run the word processing program and the screen reader was very easy. My desire for nice looking English papers also sped up the learning process. While working on one such paper, I needed to indent some lines of
7.2 text to set off a quotation; this led into learning how to set margins. During another paper, I realized that I had put a paragraph in the wrong place; leaving it where it was would have resulted in an improper example. I asked if I had to rewrite the paragraph in the place where I wanted it, or, since I was working on a computer, was there a way to move it? Yes, I was told, I could just move the whole paragraph! I was shown how to mark, erase and move blocks of text. It was extremely easy.

When the beginning or end of a block is marked, or when a command is given to the computer telling it that you want the printer to underscore or boldface text, the word processing program that I use puts little control symbols on the screen that my screen reader will enunciate. This allows me to tell that my block is marked properly before I move or erase it, or that the underscoring begins and ends at the right place. This is invaluable to me not only because it eliminates mistakes and loss of text, but also because it enables me to turn in papers that are on a par with, or better than, my sighted classmates.

Many word processing programs simply highlight or dim the area on the screen that a person wishes to underscore or mark. Until recently, this highlighting or dimming would have resulted in problems for blind computer users simply because screen reading programs could not determine colors or their variations. Now, however, most of them can, and those that still cannot are working to include this ability into new releases of their programs. I realize that computers were made for visually oriented people, but the number of blind people using them is going up significantly. I hope that, one day, software companies will examine the blind market before they put out a product. Instead of a date's being in a certain color to show a fully occupied hotel or plane on that date, a company might wish to consider using letters or symbols that any screen reading program could read without difficulty. For me, and probably for most blind people, letters and symbols are easier to deal with than colors.

For a blind person to use a computer efficiently, he/she must, of course, have a good screen reading program. The screen reader must be able to mesh effectively with the program that the blind person is working on, whether it be word processing, data base management or a spread sheet. This means giving the blind person immediate knowledge of cursor position, the page, line and column number of the cursor in the document and on the physical screen and anything else that a sighted person has access to quickly with his eyes. It also should be able to distinguish abbreviations from words, and in the case of an abbreviation, pronounce the letters individually rather than trying to pronounce them as a word.

A new user sometimes has trouble understanding the monotone and electronic voice of most speech synthesizers; to accommodate, a screen reader should have phonetic spelling. This would enable the user to hear a word beginning with the letter he is having difficulty hearing. The synthesizer might say, "t tango."

From my own experience, I can tell you that the letters, t, g, b, d, n and m are some of the hardest to distinguish.

The screen reader should also be able to read the question or prompt lines. When I give the computer the command for opening a file, for instance, a question asking for the name of the file appears on the screen. I can read this and any other prompts with my screen reader. I can also read my answers before I enter them into the computer. This way, I can ensure that whatever I want to enter is typed correctly.

There are many different screen reading programs
available, just as there are different word processing
7.4 programs. Deciding on which screen reader to use was
not difficult for me. I've read the manuals for some of
them, tried a couple and have decided to continue using
the one that I was taught to use because I think it
is the best one. Other blind people might disagree with
me, but I like my screen reader. It is important though,
for a person to be exposed to the different kinds of
screen readers. Otherwise, how can he make the right
choice?

There are many ways that a computer can assist a blind college student. One of the things it can do is give the student a sense of self-worth. With just an extra piece of hardware, (the speech synthesizer) and a software screen reader, I have learned to operate a system that was designed originally for sighted people. And the best thing about it is that the system is affordable, not like those ten thousand dollar computers I mentioned earlier. I am writing this on my own computer, in the comfort of my den. While I will always work at the High Tech Center, there are so many things I can do at home now, such as writing letters and doing work for the organization of which I am secretary/ treasurer. I like that feeling of independence.

Kevin

At the age of thirteen, I lost most of my central vision due to a congenital eye disease called Stargardts. I am now twenty eight and I have lost all of the central vision that I had left. Being partially sighted has never really been much of a problem to me with the exception of reading, writing, or seeing blackboards at school. During my high school years, I learned to adapt quickly to my loss of vision. I was aided by the use of various magnifying lenses, binoculars, and large print books. The large print books were rather cumbersome but, nevertheless, they allowed me to read with less strain on my eyes. I was quite fortunate toward the end of my second year in high school. My parents purchased for my use a special closed circuit television that would enlarge reading materials placed under the camera. This allowed me more freedom to read different materials that I could not obtain in large print. Despite all of these aids, reading was still very slow and fatiguing.

Upon graduating from high school, I went straight to a community college. There, I painstakingly completed two semesters of college with a 2.8 grade point average using just my closed circuit television system. At that time, I felt like I was just spinning my wheels and could do better without school. School was too difficult to contend with. Unfortunately, I was not aware of the supportive services available to visually disabled students in California community colleges.

After quitting school, I worked hard at a resort which was open eight months out of the year. I eventually worked my way up to becoming the dining room manager and wine buyer. During the four months that the resort was closed I lived at different ski areas and eventually ended up teaching skiing at a resort in the Sierras. I also worked very hard at this job and became the instructor who taught all of the handicapped individuals who came to the resort to learn to ski.

I became tired of what I was doing and realized the value of having a college education so I left that life style to return to school. During the eight years that I was away from school I had developed a great deal of discipline. During my first year back at college, I became one of the top three ranked, blind ski racers in the world; competing in the world championships in Sweden as a member of the United States Disabled Ski Team. *7.6*

In everything that I do, I always strive for excellence, however I felt rather inhibited recalling my past experience with school. I was very fortunate in being introduced to a wonderful member of the supportive services staff at my community college. She introduced me to text books on tape and other forms of assistance which I never knew were available to me. She was one of the most supportive and kind individuals I have ever met and she made my transition back to college very easy and smooth.

She was also responsible for the most useful and practical introduction that a partially sighted person could ever hope to have: my introduction to adaptive computers. I was taught how to operate a computer that used an adaptation which displayed everything in enlarged, bold print on the computer screen. My steadily growing knowledge of the computer has proven to be a tremendously powerful tool for school work and my personal needs. The computer has allowed me to learn how to type and edit papers in a fraction of the time that it would have taken me otherwise. It has taught me organizational skills, and believe me if anyone needed organizational skills, I was most certainly the prime candidate! Also, being partially sighted, I really don't read very much because it is so slow and fatiguing. And, with my particular eye condition, when I read, often times parts of the words will literally disappear. What I am trying to say is that I am terrible when it comes to spelling. Working with the computer has allowed me to visually see, rather than hear words, with a great deal of ease. So, essentially. the computer has greatly improved my spelling (thank goodness) and expanded my vocabulary probably ten fold.

I have told you my experience of working with adaptive computers but I can't really put into words the freedom that it has allowed me. Freedom to express my thoughts in a way not possible before. I really can't thank the supportive services staff at my college enough for their support, assistance, and knowledge. Academically, I feel like they have let me out of a very small dark box with my new found tool. I have now brought my grade point average up to a 3.3 and will be transferring to a major university to complete my education.

The adaptive computers at my college have helped me tremendously. They have also provided me with a new and extremely valuable skill. I have seen others with varying disabilities working here at the high tech center and they share the same feelings I have. The center has provided its people a great deal of freedom to learn. They are also able to discipline and express themselves, an opportunity they may not have had before.

Robert

My name is Robert, and I am a quadriplegic with no functional use of my hands.

Two years ago I was a deeply concerned and frustrated individual because seemingly all avenues to a productive and meaningful future were blocked by some facet of my life. I was fearful and held out little hope of fulfilling my dreams of again becoming a contributing member of society.

When I became aware of the innovative High-Tech Center for the Disabled, I called Monterey Peninsula College to inquire about the program and was enthusiastically encouraged by the Center's staff; hope of finding some feasible way to overcome some of those obstacles was rekindled.

With the backing of caring parents and a supportive State Department of Rehabilitation Counselor, I nervously began Adaptive Computer Classes. *7.8*

I first learned Mindreader, a word processing program which made it possible for me to produce letters and other documents twice as fast and more accurately than I could produce them on an electric typewriter. Address files, formatting and many other functions which Mindreader offers are very useful and exciting to be able to achieve.

The program Director asked if I would be interested in a CAD (Computer Assisted Design) Program he was adapting — I was very interested!

I now can draw plans easier and faster with this CAD Program than I was able to do when I had full use of my arms and hands. I am now learning Architectural Drafting and am using this CAD Program to draw all the necessary plans to build a home.

As I become more proficient in the use of the CAD Program, it seems feasible that I will have a marketable skill.

Due to the support and encouragement of so many, and because of the ability of the High Tech Center computer adaptations to accentuate the abilities of the user while forgiving his limitations, I have been given a new outlook on life.

Where before I saw only obstacles and despair, now I see opportunity and ways to overcome those obstacles and feel I am on my way to fulfilling my dreams.

The staff of the High-Tech Center's insights and knowledge of the needs of disabled people have been beautifully integrated into the Adaptive Computer Program. This program opens the channel to let flow the intellect and creativity that has until now been restricted.

The Adaptive Computer Program which was initiated by Mr. Brown at Monterey Peninsula College is being instituted throughout the California Community College system. The program offers the disabled the promise for feeling real worth and a realistic hope of obtaining meaningful employment.

This program will allow the disabled the opportunity to express and develop their aspirations and dreams and will provide society with a new source of ideas and talent. It will also give the disabled the means of obtaining the dignity of being contributing and respected members of society.

Jay

As a person who manages information for a living, I find it ironic that my learning disability has had such an impact on how I handle the written aspects of my work. Today, after years of trying to "pass" in a world that writes on a casual basis, I realize that my hand was not created to hold a pen. I still am learning to deal with being a nonwriter in a writing world.

As has happened with many other learning disabled (LD) adults my age (35), I did not find out about my disability until I was in my late 20's. I still am learning to understand it seven years later. All my life, I knew that there was a difference in me—that I fit differently and did things differently than others. Today, looking back, I can assign names and causes to my "different ways," which in today's more aware times, I call my "coping skills." I look back at a childhood filled with problems in processing auditory and visual input (hearing "laboratory" for "lavatory," unable to ride or even look at an escalator) and attempting to cope with the intermittent social skills that seem to plague most LD folks.

It's almost easy now to repeat the litany of problems faced; almost easy, but the facile repetitions do
7.10 not hide the anger that I felt then and that still can surface. Most of the time my anger isn't part of my life, but sometimes the emotions generated by over thirty years of dealing with differences both subtle and blatant do break through. When the way that I surmount my disability runs counter to the rest of the world, and my differences do surface, my rage can be deep and frightening.

One such instance came after my latest housewarming. I have severe dysgraphia, so any writing becomes a task delayed until I find a way that I can lessen the contact of pen to paper. For a party both invitations and thank-you notes become a dreaded chore, delayed, denied and then done hurriedly, skimped and second-rate. But for this party, I did everything right!

With the help of my trusty PC, I composed invitations, made labels, and mailed my invitations. Again using the PC, I listed all information about the guests, and left room in the file for information on who came and what gifts they gave. At the party, I asked my mother to list the gifts and who gave them in the guest book (so I did not have to write at all). The next day, I transferred this information into the computer and fed in name, address, gift, and attendance information, and printed out thirty individual thank-you notes.

After thirty years of fighting paper, pencil, and pen, I had substituted a keyboard for the paper, pens, and correction fluid that I had always used in such quantity. The PC and its associated equipment freed me from the pain of moving words from my mind to paper, so that within an hour and a half of sitting down at the machine, I had my thirty thank-you notes, individually written, or at least some individual text in a form note, printed in script onto notepaper, and labels typed onto the envelopes. All of this in ninety minutes! Each letter of each word looked the same—the same size, shape, going in the same direction, and perfect, every page unmarred. Never before had I been on time in sending thank you notes or in any other writing task!

Until I discovered the word processor, writing remained a painful task, each draft an agony of crossing out, and forced brevity in expression. I had always used a word in place of a sentence, a sentence in place of a paragraph. Even if my ideas flowed, and my fingers were fresh and the pencils sharp, each page looked like a drunken chicken had staggered across the page. My letters slanted to the right, to the left, above and below the line, letters slammed into each other, crookedly running off the page.

I looked at those envelopes, triumphant!! The act of writing, mine at last!

I went to share this milestone in my life with my girlfriend at that time. Her response was shocked disapproval! How could I thank all of my friends and family with a computer? How could I be so crude and low-class, what kind of manners did I have? Feeling shocked, hurt, and bewildered, I started to explain dysgraphia and LD, but, for her as for many others, LD is a code word for "lazy," "stupid," or "not willing to work." As I explained to her why I wrote with a computer, I relived all of the pain of countless rewrites, of recesses lost to practicing penmanship, of rulers across the knuckles, of red ink on papers already watered with my tears, tears matched by the tears in my eyes as I described my struggle, and joined by the tears in my eyes as I relive it now.

Recording my thoughts on writing, focusing on
being different and not knowing why, I have relived
thirty years of seeking ways to move my thoughts from
the inside of my eyes to the paper. First to try to form
the letters, to keep them even, and to let them march
across the paper, then to organize them, sequence them
to make sense outside of my head, into conformity
7.12 with the rules of grammar and spelling, drafting and
redrafting, meeting the tasks of any writer. After thirty
years, it's doable! I never thought of it before, but the
keyboard lets the words out of my fingers, and flows
them across the screen, checks and changes the spelling, reverses the reversals, making me unafraid to write.
I gladly accept the limits of this new freedom, I write
only at the typewriter at my desk, on the word processors outside my office door, on the PC at home or on
the additional six pounds of battery typewriter I carry
with me. It's a small price to pay, being limited to a few
locations, because at those places I have the freedom to
write, something I never dreamed I would have.

Although I know that time and technology have only now come together to flow my words into the world, I still ask, "Where was this magic in my childhood? Where would I be now if I had had access to it then?" If I had had a keyboard instead of my fickle fingers . . . I don't know and never will know, but I'm free now. Fingers on keys, words march from behind my eyes across the page, clear and crisp, polished to a glitter by the magic of technology. Each word, crisp black on spotless white, affirms once again that I can do it, at last . . . I CAN WRITE!

Funding the High-Tech Center

OK, so now you're convinced Adapted Computer Technology is a good idea and something that your campus should make available to disabled students, but where does the money come from to buy the equipment, train the staff, pay salaries and all the rest? It can and has been done and perhaps more easily than you might imagine.

By Martha Kanter
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Introduction

The rapid growth and increasingly sophisticated use of computers and other emerging new technologies demand that college students have immediate access to equipment and software. Many universities across the country are developing microcomputer networks, computer laboratories and classrooms in order to take instructional advantage of these new technologies. All students must have access to these new classrooms, instructional methods and techniques.

More recently, microcomputers across the post-secondary curriculum are being introduced, most usually with a 2-4 week introduction to computer use. What about a student with a disability who needs a particular computer accommodation? Consider assignments that must be completed in a computer lab or in the library's computer room. Will this equipment be made accessible to students with physical disabilities? What thought is being given to these and other problems in providing access to all students as colleges plan their expansion into these new technological worlds?

Since the passage of the Civil Rights Act of 1964 and the Rehabilitation Act of 1973, as admission to college has become more equitable to groups previously excluded on the basis of race, age, sex or disability, more disabled students are attending institutions of higher education. In fact, the recent Harris Poll completed in March, 1986, entitled "The ICD Survey of Disabled Americans" states that 14% of all disabled persons between the ages of 16 and 64 are college graduates. California statistics from a recent report from the California Post-secondary Education Commission show a dramatic growth in the disabled population throughout all segments of public higher education. In the community colleges alone, the number of disabled students increased fivefold from 5,000 to over 50,000 in this past decade since the inception of Section 504 of the Rehabilitation Act of 1973. Colleges have responded to meet the educational needs of these nontraditional students through providing support faculty and staff charged with ensuring adequate and appropriate accommodation.

Typically, a campus has employed or appointed one of its staff as administrator or dean of student services with responsibility for providing equal access for students with disabilities. For example, in private universities such as Yale or Stanford, the Director of Disabled Student Services carries out responsibilities for providing support services to students with disabilities. Similarly, in public institutions such as the 106 California community colleges, each college has a Director of the Disabled Students Program. While titles and positions vary from campus to campus, the jobs are the same—accommodating disabled students on the college campus.

As colleges address microcomputer access for disabled students, the Disabled Student Services Director—whether faculty member, administrator or dean—will find a way to assist disabled students in surmounting any educational barriers encountered on their way toward graduation and employment.

How will my college provide microcomputer access for Joanne who has only one hand? Or for Roger who is blind? Or for Fred who has cerebral palsy?

Investing in the Idea and Demonstrating the Need

Whether a particular disabled student first experiences difficulty gaining access to a microcomputer or whether a faculty member or director of disabled student services engaged in comprehensive institutional planning addresses the problem before any barriers have been identified, the need is the same: *providing disabled students access to microcomputers*.

It is difficult to imagine why any college would not want to provide such access, but lack of funds is a common reason for not going ahead with a good idea, much less a requirement of a curriculum which must be made fully accessible to any student who has been admitted to the college or university.

So, it becomes the job of the Disabled Student Services Director to find a way to do it. Investment in the idea is perhaps the strongest factor in developing this resource for disabled students. Most importantly, having the ongoing vision of students with disabilities accessing microcomputers (and any other hardware or software device available on a college campus, for that matter) as an integral part of their undergraduate or graduate education makes it rather easy to find money to fund the high tech center.

What are the steps?

First, some strategic planning is in order. Putting together a prospectus will help the idea take shape and be communicated to others who will assist in resource acquisition. The goal is simple. Translating the goal into action requires energy and commitment. The plan should be concise and convincing. It should encompass the following elements:

1. **Statement of purpose**
   a. **how microcomputer access is an integral part of the college or university mission**
   b. **characteristics of the students who will be assisted**
   c. **how the educational process will be improved**
2. **Statement of need**
   8.4
   a. **description of how the director, faculty and/or students have demonstrated that the need exists (perhaps a survey has been conducted, student and/or faculty interviews held, examples of course requirements made available, etc.)**
   b. **if necessary, other colleges or universities around the country can be cited as model programs (take advantage of what has been done already)**
3. **Objectives and activities**
   a. **list the steps to carry out the microcomputer acquisition and training plan**
   b. **describe how students will be accommodated, who will provide the training, what equipment is needed, where the main sites exist for adaptations to be made available (i.e., library, specific classrooms, learning center, etc.)**

4. **Budget**
    a. **set up several hypothetical scenarios (i.e., providing accommodation for individual students, for a department, or across the campus)**
    b. **attach a budget to each scenario which includes one-time equipment purchase or adapting existing equipment on campus, specific adaptations, staff supervision costs, ongoing supplies and materials (i.e., computer paper)**

Sharing the Vision

Once the basic plan is in order, evaluate your particular campus culture and identify your strongest advocates for the project. Most likely, several disabled students, a couple of interested faculty members, occasionally a disabled faculty member or administrator, someone from the college Finance Department and one or two community resource persons will comprise the team. It is important to remember that you can't do it alone. A good idea will be supported by many people and it is important to have the benefit of a team as there will be many spin-off components to your plan which, at this stage, you may not have yet considered.

How is this vision best shared? Establish a task force, informal network or college consortium and call a meeting for the purpose of reviewing your outline and helping with the formation of the vision. It is in this stage that the needs assessment can be conducted—perhaps a survey of existing disabled students and faculty members. Staff and students should be included in the planning effort. Sometimes a catchy title helps with this phase.

For example, "Monterey Peninsula College Advisory Committee on Microcomputers and Disabled Students." Or "Dean Thatcher's Ad Hoc Committee on High Technology and Students with Special Needs." Better yet, "President Johnston's Commission on Microcomputers, Disability and Higher Education." At this meeting, consider bringing in an outside resource person to illustrate how disabled students will be helped in this effort. Or have some interesting microcomputer demonstrations, showing how disabled students can be easily accommodated. You may also want to consider a panel of one or two disabled students discussing the problem and providing examples of the "vision."

8.6 Finding the Start-Up Money

As sharing the vision will be an ongoing part of making computer access a reality on your particular campus, a concurrent effort must be undertaken as quickly as possible to find seed money to start the terminal rolling. All possible sources of revenue for this project must be considered. At Monterey Peninsula College, it was especially helpful to work with the Director of Fiscal Services. Mr. Don Young was most knowledgeable about funding sources and, as it happened, he was also committed to providing computer access for disabled students. A neophyte computer user at the time, he was especially interested in learning about new microcomputer adaptations. The project was exciting, and many of the software adaptations were drawn from business or industry and were never designed with the disabled population in mind. Some possible sources of funding to consider are:

1. **Student services special funds for nontraditional students**
2. **Instructional equipment funds**
3. **President's or Chancellor's discretionary funds**
4. **Service club funds (e.g., Kiwanis, Rotary, Quota, Soroptimist)**
5. **Foundation sources (e.g., Handicapped Funding Directory)**
6. **Local grantsperson or community grantsperson**
7. **Public service TV campaign**
8. **Telephone campaign**
9. **Establishment grant from the Department of Rehabilitation**
10. **Student clubs—make this a student project**
11. **Other community resources**
12. **Special grant funding**
13. **Public service agencies**
14. **Vocational Education Act funds**
15. **Alumni fundraising activity**
16. **Special event (i.e., sporting event or concert) earmarked for this project**
17. **College or university trustees who may have a special interest in this kind of project.**

For public sector colleges and universities, the budgets are public documents and should be searched for all possible sources that might be tapped for the project. The support of Finance and Administrative Department personnel cannot be emphasized enough. If they are invested in the idea, then enthusiasm and excitement will be generated and unsuspecting sources

found which you and/or members of your team can pursue.

At Monterey Peninsula College, two subprojects were initiated to accommodate two disabled students with severe orthopedic impairments who needed unique and specialized systems in order to use microcomputers. One project raised $3,000 for one student and another $35,000 so that both students could have specialized augmentative communication systems to access microcomputers on a daily basis. In these efforts, community service clubs and private donors gave funds through separate accounts set up through the Easter Seal Society as the college's function and mission was to provide on-campus accommodation.

Broadening the Vision

8.9

Concurrently, you will want to ensure that a small group of three to six individuals serves as the project steering committee. A first task of this group will be to appoint a project director and share responsibilities in the tasks outlined above. A second task for all of the members will be to spread the word about the project and essentially sell the idea to the at-large campus community. Talk it up! College and university faculty and staff make approximately 200 contacts with different individuals each week. At meetings you attend or when you are interrupted during the day by someone who has an important question, take a few minutes to give the project the visibility it needs. If there are five people on your steering committee, multiply 200 x 5. The opportunity for 1000 contacts each week will certainly help you build the kind of network you need so that others can share the vision.

At the same time, it is critical to stage one or two events on campus as well. For example, Yale University held a two-day "Forum on Adapted Computer Technology Systems" and invited several national speakers as well as local vendors to the campus computer center to display microcomputer adaptations for students with disabilities and to discuss adapted computer technology in general, research implications and funding strategies. Another example was to have one or two faculty and several students go on cable television, demonstrate the adaptations and discuss the need for microcomputer access to a wider audience. A call-in number should be made available so that those wishing to participate or provide funds can do so. The net result of these kinds of activities is a broader shared vision which will help the project succeed.

8.10

Adapted Computer Technology—A Campus Reality

Finally, it is important that the evolution of a high tech resource center on campus develop from within so that departmental faculty will be continually involved in its operation, both from the standpoints of curriculum and referral. As faculty are becoming increasingly aware of adapting their curricula for microcomputer usage, and as more individuals with disabilities are able to attend institutions of higher education, the curriculum of the future will be increasingly dependent upon microcomputers. It is in this light that access considerations must be addressed so that disabled students can be accommodated in all phases of new curricular requirements and assignments. As the field of cognitive science continues to demonstrate how information is processed and learned in numerous modes and through a variety of channels, it is likely that the requirements of access for persons with disabilities will take on new dimensions. In fact, being blind may become a new and different experience given new adaptations that are introduced for purposes of accommodation. Faculty involvement becomes crucial from a research standpoint as well. As interdisciplinary work continues in the fields of rehabilitation engineering and computer science, we can expect to reap the benefits of improved microcomputer adaptations for students with disabilities. New developments in these fields can be field tested in these sites, and adapted computer technology studies conducted. The public policy implications of providing adapted computer technology for students with disabilities are far reaching on several levels. The most basic is affirmative action. With available adapted computer technology, disabled students will be accommodated on campus. The university or college will continue its commitment to a comprehensive student body, representative of all groups, including the disabled. On a second and perhaps broader level, the disabled, the most severely underrepresented minority group in the country, will have increased opportunity to achieve their educational goals and succeed in post-secondary education and employment.

Computer Access, Disability and the Law

Access to computers for disabled individuals is more than just a good idea. Soon, it will be mandated by law. Helping colleges, universities, business and the research community comply with these new regulations will provide a variety of dynamic and productive challenges in the years to come.

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Introduction

As new technologies are introduced into the marketplace and become more commonplace in the post-secondary environment, the challenge to accommodate disabled students is presented to colleges and universities on a daily basis. Many new adapted computer technologies clearly do not place an undue financial burden or hardship on an institution. The issue, then, is how to quickly and easily make it possible for students with disabilities to take advantage of these new technologies.

Not only is the college or university committed to providing a comprehensive education to all matriculating students, but numerous federal and state laws exist which mandate that institutions provide equal access to educational opportunities for all students. Civil rights legislation of the 1960's required that universities adopt affirmative action policies for their students and employees to avoid discrimination on the basis of age, race or sex.

Section 504 of the Federal Rehabilitation Act of 1973

Section 504 of the Rehabilitation Act of 1973 states:

> No otherwise qualified handicapped individual in the United States . . . shall, solely by reason of his handicap, be excluded from the participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance [29 U.S.C. sec. 794, as amended by Section 111(a) of the Rehabilitation Act Amendments of 1974].

In general, this act prohibits discrimination on the basis of handicap in federally funded programs and activities. It also applies to institutions receiving any sources of federal funding. Further, Section 101.42 of the implementing regulations, 34 C.F.R. Part 105, extends to nondiscrimination on the basis of handicap in admissions and recruitment. This piece of landmark legislation describes "reasonable accommodation" as the method for ensuring the nondiscrimination of disabled persons. Across the country, institutions have taken broad steps to make education more accessible to students with disabilities. The decade of the 1970's saw great emphasis on the removal of architectural barriers on campuses so that students in wheelchairs could get into classrooms. Elevators were built so that students with physical disabilities could access classrooms on all floors of campus buildings, not only on the first floor. *9.2*

Following the Architectural Barriers Act of 1968, states formed Architectural Review Boards with extensive requirements for construction of buildings and pathways that are built to codes which require accommodating the disabled. Reflecting on what was built in the past, how could our planning have been so shortsighted as to have constructed engineering centers or humanities laboratories from which students with physical disabilities were barred by architectural design?

Additionally, the United States Department of Education set forth regulations on Section 504 (34 C.F.R. Part 104), establishing standards for institutions of higher education to follow in meeting the needs of disabled students and employees. In fact, the Department further stated that "different or special treatment of handicapped persons, because of their handicaps, may be necessary in a number of contexts in order to ensure equal opportunity." [42 Fed. Reg. 22676 (May 4, 1977)].

Adapted computer technology, based primarily in software adaptations, permits full access to commercially available and professor-authored software programs, individual microcomputers, networks and mainframes. It is reasonable to expect that institutions will take proactive steps to accommodate the computer access needs of students with disabilities. There can and most certainly will be legal consequences in not doing so as equal access and equal opportunity continue as guiding principles in college admissions and academic participation.

Supreme Court Opinions

As a case in point, in the 1979 Supreme Court case, *Southeastern Community College v. Davis*, our highest court recognized the emerging needs of the disabled in terms of advances in technology:

> We do not suggest that the line between a lawful refusal to extend affirmative action and illegal discrimination

> against handicapped persons will always be clear. It is possible to envision situations where an insistence on continuing past requirements and practices might arbitrarily deprive genuinely qualified handicapped persons of the opportunity to participate in a covered program. Technological advances can be expected to enhance opportunities to rehabilitate the handicapped or otherwise to qualify them for some useful employment. Such advances also may enable attainment of these goals without imposing undue financial and administrative burdens upon a state. Thus, situations may arise where a refusal to modify an existing program might become unreasonable and discriminatory. Identification of those instances where a refusal to accommodate the needs of a disabled person amounts to discrimination against the handicapped continues to be an important responsibility of HEW. *Southeastern Community College v. Davis* [442 U.S. 397 (1979) at 412-413].

9.4

Although experts in adapted computer technology and disability continue to find that colleges and universities act in good faith to provide equal opportunities for students with disabilities, more often than not, academic programs are developed or revised without much thought as to how disabled students might be accommodated. For example, a large Eastern university received a major federal grant to design a word processing system which was to be used by a multistate consortium of colleges and universities to teach freshman composition. The primary design concept of this word processing system revolved around the use of high resolution graphics text displays. Unfortunately, these kinds of displays cannot be translated to speech output for blind users.

This system when completed will be entirely inaccessible to blind students attending any of the colleges or universities participating in the project. What will most probably occur for the blind student? The university will pay a reader to sit at the terminal and describe the contents of the display. What could have happened? The design team for this project, including its engineers, might have used another type of architecture so that the visual displays could have been read by a voice synthesizer and heard by the blind student using earphones in the computer lab.

Remembering to "think before doing," the Court recognized that, while efforts are made in good faith, the net result may have exclusionary consequences, necessitating that systems and programs be redone to stop any possible invidious effects on persons with disabilities. In *Alexander v. Choate*, the Supreme Court states:

> Discrimination against the handicapped was perceived by Congress to be most often the product not of invidious animus, but rather of thoughtlessness and indifference—of benign neglect . . . For example, elimination of architectural barriers was one of the central aims of the Act, yet such barriers were clearly not erected with the aim or intent of excluding the handicapped. *Alexander v. Choate*, [105 S.Ct. 712 (1985) at 718-19]. *9.5*

Fortunately, new legislation is being put forward which will obligate institutions receiving federal support to provide technological systems which the disabled will be able to access as easily as the able-bodied. Universities which receive federal grants, contracts or gifts from agencies such as the National Science Foundation, U.S. Department of Education or Department of Defense will have to demonstrate how they plan to adapt for disabled students and disabled employees.

Section 508 Amendments

Specifically in regard to adapted computer access, the 1986 amendments to the Federal Rehabilitation Act of 1973 put forth new language which will have a dramatic effect on the future of computer access for hundreds of thousands of disabled persons. Broadly referred to as "electronic curb cut legislation," when fully implemented, the impact of these new access requirements will be of enormous benefit. The language in its entirety reads:

> Title V. Miscellaneous
>
> A new section (508) Electronic Equipment Accessibility has been added.
>
> Sec. 508.(a) (1) The Secretary through the National Institute on Disability and Rehabilitation Research and The Administrator of the General Services, in consultation with the electronics industry, shall develop and establish guidelines for electronic office equipment with or without special peripherals.
>
> (2) The guidelines established pursuant to paragraph (1) shall be applicable with respect to electronic equipment, whether purchased or leased.
>
> (3) The initial guidelines shall be established not later than October 1, 1987, and shall be periodically revised as technologies advance or change.
>
> (b) Beginning after September 30, 1988, the Administrator of General Services shall adopt guidelines for electronic accessibility established under subsection (a) for Federal procurement of electronic equipment. Each agency shall comply with the guidelines adopted under this subsection.
>
> (c) For the purpose of this section, the term special peripherals means a special needs aid that provides access to electronic equipment that is otherwise inaccessible to a handicapped individual.

The committee, formed under the auspices of the National Institute of Handicapped Research to establish access guidelines for electronic office equipment is called The White House Committee for Equal Access to Standard Computers and Information Systems.

If they have not already done so, administrators in institutions of higher education must become familiar with this language and consider how adapted computer technologies can be implemented for students and employees with disabilities to meet these requirements as quickly as possible.

Meeting the New Computer Access Requirements

9.8 The politics of access remains an important consideration, since old ways of doing things will require change. For example, faculty in computer science who may never have had the opportunity to teach a disabled student might, of necessity, be asked to implement these new technologies in the classroom as part of the instructional methodology. Of what benefit? That the college or university can offer all students—including students with disabilities—equal access to its educational programs.

Colleges and universities must also pay attention to accessibility requirements in incorporating new software applications which they may be interested in purchasing for student use. For example, computerized college placement and diagnostic tests will be increasingly available for use in admitting and placing students in college courses. Institutions must ask questions now as to how disabled students will be accommodated if they adopt these new systems.

Looking ahead to the year 2000, it is incumbent that we consider reasonable accommodation as a regular part of institutional planning. Within the domain of adapted computer technology, college faculty and administrators must respond to the microcomputer onslaught in the college classroom and campus environment through informed decision-making.

Simple steps can be taken to ensure that students with disabilities can use microcomputers and mainframes as an ongoing part of their college education. In many cases, accommodation is simple. What can institutions do?

1. First, in planning microcomputer and mainframe use at an institution, consider that an ongoing portion of students will need to be reasonably accommodated due to visual, physical, hearing or learning disabilities. Design an accessible system.

2. Next, keep abreast of software packages that
permit reasonable accommodation for the disabled *and* 9.9
allow nondisabled persons access as well.

3. Third, it is critical that institutions pay particular attention to how public information is made available to the campus and at-large community and that, wherever public information is available, the institution ensures that persons with disabilities have access to this information as equal members of the college community.

For example, if students are required as part of the college curriculum to access LEXIS, Dow Jones or ERIC databases, questions such as "how will a blind student use this terminal" or "is the library's computer which contains ERIC accessible to a student in a wheelchair" must be answered. If all students at an institution are given a microcomputer or are required to use ones available in the campus center, student lounge or dormitory, how will disabled students be accommodated? Adapted computer technologies provide answers to these questions and enable institutions to provide the very best through hardware and software accommodations that are becoming increasingly commonplace.

4. Finally, keep abreast of new federal and state laws and higher education policy studies which focus on using these new computer technologies and the requirements of students with disabilities. These emerging new technologies must relate directly to the goals and objectives of affirmative action, Section 504, and the U.S. Department of Education's institutional compliance requirements in regard to program accessibility and the provision of auxiliary aids to students with disabilities.

9.10 Conclusion

Higher education leaders should expect that standards will be developed for adapted computer technologies (see 508). Clear criteria, use requirements and guidelines, and access issues will comprise these standards. In short order, these standards will become law or administrative rulings governing institutions of higher education. For example, in the California Legislature, a bill was introduced by Assemblyman Tom Hayden in 1986 promoting ergonomic requirements for office environments which use computers. Applying this kind of legislation to the needs of disabled persons, it is likely that institutions which receive federal funds and which require computer access for all students will need to prepare for such standards as soon as possible.

It is important that we remain cognizant of lessons past. While buses have been available to carry passengers across town for the past fifty years, it is only within the last decade that these same buses have become accessible to persons with disabilities. As computers have, in short order, come to pervade every aspect of our environment, let's ensure that persons with disabilities can access them as easily as the rest of us so that those who choose to attend an institution of higher education will be able to take advantage of each and every aspect of what colleges and universities have to offer.

The Corporate Perspective

What does the employment future hold for disabled men and women with a successfully completed college career behind them? How can the business community utilize the skills and abilities of these individuals? New computer adaptations allow disabled persons to function as competitive and productive members of the work force. Corporations have a unique opportunity to capitalize on a newly emerging group of talented and highly motivated individuals.

The author has attempted to explore what corporations can do to assist the disabled person in job training, accommodations, and employment. This report gives examples of initiatives in general, not all of which are unique to any one company, including the author's employer.

Corporations have a unique opportunity to expand the horizons for people. They can provide accommodations for disabled employees and use their technology to develop products that enhance the quality of life for the disabled community. These activities, in turn, often benefit people without disabilities.

This chapter discusses how the private sector can help the disabled person, both in business and in life. It also discusses the need for companies to ensure that products are accessible to the disabled community.

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When Employees Become Disabled

"Where would I be without all this stuff? Possibly without my company, without the equipment and help, probably in a rehabilitation home somewhere, shuffled off in a corner." This was the reply a young man, who had become a quadriplegic after a motorcycle accident, gave a television reporter. It points out very succinctly what companies can do for employees who are disabled.

Even though he is now a quadriplegic, he is still making valuable contributions to his company. When he first joined, he was a systems engineer. After the accident, the company retained him as a programmer and provided accommodations to enable him to accomplish his work. The accommodations included physical changes to his home and a terminal which allow him to work at home and to communicate with colleagues. Since he cannot use a keyboard, he uses a speech-recognition system instead.

Another company gets involved immediately when one of its employees becomes severely injured *10.2* and needs a long recovery period at home. It works with its medical department, the state rehabilitation agency, and other key organizations to enable the person to start working again as soon as it is medically possible through a home terminal. Not only does recovery often occur faster, but the injured individual has a chance to keep occupied during the recovery period. The program has proved so successful that the company now markets the service for a fixed fee and two other companies have adopted the model.

These two examples show what can happen when companies make the extra effort to retain employees who become disabled.

Hiring Disabled People

The service industry, too, has had its share of success with disabled employees. For many years, a national fast-food chain has encouraged hiring mentally retarded people, with positive results.

However, an establishment does not have to be a national organization to successfully hire disabled people. There is a small restaurant in Connecticut where 60% of the employees have a learning or another mental disability. The owner is very pleased with the quality and productivity of their efforts. They earn competitive wages and stay for one to three years. When they leave, they usually find jobs with other restaurants at prevailing wages.

Providing Employment Opportunities

There are more disabled people in the work force than
many employers realize. Out of 240 million people in
the United States, 36 million are disabled, with 17.2
million (one in 12) of working age. Worldwide, the 10.3
United Nations estimates that 500 million people have
disabilities.

Not all of these individuals were born disabled. Five out of every six became disabled during their working or retirement years from accidents or sickness.

That last statistic shatters any stereotypes that persons with disabilities are generally young people seeking jobs rather than older persons with an established work history. It also shows that employers are very likely to have employees who become disabled after they are hired.

Whether they have employees who become disabled or whether they hire disabled people, employers need to be aware of the accommodations they can provide to enable disabled employees to make the best use of their skills. If they have employees who become disabled, the benefits of providing accommodations for them are obvious. The company gets back valuable,

experienced, and still productive employees. Government retains taxpayers instead of having to provide disability payments for each disabled individual who cannot find employment.

But most of all, the people who are now disabled regain their self-esteem and some of the independence they had before becoming disabled. They are still a productive member of society, which is important to those who have worked most of their lives only to be slowed down by an accident or a debilitating disease.

When companies hire people who are disabled, they often find that such employees have performance and attendance records comparable to their non-disabled colleagues. One executive said recently, "When a snowstorm hits Colorado, I know which parking spaces will be filled first—the ones reserved for the disabled. They're here before most of the non-disabled persons." The disabled have fewer accidents, which means that they are good insurance risks, and their insurance rates do not affect Worker's Compensation rates. Disabled employees also tend to have a lower turnover rate.

Providing Accommodations

How can corporations help disabled employees or those who become disabled? First, they can provide accommodations if they are needed to make performing tasks easier. There is a wide range of accommodations at varying costs that are available for employees with various disabilities. According to a Louis Harris survey of managers of 210 different companies, 80% rated the cost of accommodations as "not too expensive" or "not expensive at all."

Simple accommodations can assure the productivity of disabled employees. Blocks under desks so wheelchairs can fit under them are an example. Another is the removal of doors so wheelchairs can pass through them.

Other simple accommodations are braille or audio versions of written documents for visually impaired employees. Sign language interpreters and open captioned versions of videotapes can be provided for the hearing-impaired. Keyboard guards are available for those who have trouble handling the keyboard, such as those with cerebral palsy. (These guards enable only one key to be struck at a time.)

More sophisticated accommodations are speech synthesizers for the blind or speech impaired. Others are voice recognition systems or keyboard emulators for the upper-mobility-impaired individual.

There can be side benefits to providing accommodations for disabled employees, such as an increase in overall productivity. For example, a manager obtained an experimental voice recognition system for a technical editor who was a quadriplegic. After the system was installed, the manager found that the impaired employee had significant productivity increases—so much so that he was outperforming his ten nonimpaired colleagues. As a result, he ordered another ten systems for the department. *10.6*

Management Training Programs

Companies who hire disabled people do so for two reasons, one being legislation. If they have contracts with the federal government, they cannot discriminate on the basis of religion, color, ethnic background, or handicapping condition. Of all the companies with federal contracts, 75% have hired disabled people during the past three years (65% in 1986) according to a Louis Harris survey done for the International Center for the Disabled. In comparison, 52% of companies without federal contracts have hired disabled people in the past three years (48% in 1986).

The other factor, company policy, is even more effective and encompassing. Of those companies with a policy of hiring disabled people, 80% have hired the disabled, with 67% doing so in 1986.

When companies hire disabled people, managers are the critical link between the disabled employee and the company. The decision to hire a disabled person rests, for the most part, with the assessment of the qualifications of the applicant. It is important that managers know how to manage, train, and promote disabled employees. Appropriate management-training programs can teach them how to be a better manager to their disabled employees as well as help them to be more sensitive to their needs.

For example, written documents such as performance plans and minutes of meetings should be online 10.7
or in machine-readable form for the blind so they can use speech synthesizers to "see" what's on the screen. If speech synthesizers are not used, documents should be typed for reading by an optical reader or put on an audio cassette. A sign language interpreter should be available for the hearing-impaired for meetings, if needed, or a note-taker used. If an interpreter is not available, the manager should meet with the hearing-impaired employees beforehand to discuss the agenda so they will know what will be covered. If employees have had a spinal cord injury, the manager should be aware of their special needs concerning attendant care and availability of accessable restrooms.

Whether a large corporation or a "mom and pop" store, the private sector can hire, train, and promote qualified disabled individuals. And it can be done not because of legislation or a sense of social responsibility but simply because it makes good business sense.

Microcomputers and the Disabled Person

With accessible computers and with products that make it easier to use computers, people with disabilities can participate very effectively in the work force. Computers not only make it possible for the disabled to handle tasks, but also make tasks easier for the nondisabled. Speech recognition systems are an example. While people who cannot use keyboards find them indispensable, people who do not like to type also like them. As a result, they are used by a wide segment of the population because they make accomplishing tasks easier for everyone, disabled or not.

10.8 When computers are made accessible to the disabled, the nondisabled user also finds them easier to use. For example, if all power switches are located in the front instead of in the back, everyone finds it easier to turn on the equipment. Another example is the capability to press two keys sequentially instead of simultaneously. This simple change helps those with a temporary disability, such as a broken arm, who cannot use both hands for the keyboard. It also benefits those who are spastic or upper-body-impaired.

Companies should be aware that new enhancements to computers may make it more difficult for the disabled to use them. For example, graphics are increasingly being used to make operating computers easier for new users. But visually impaired users who depend on speech synthesizers to read the computer display will find that their tasks are more difficult, because speech synthesizers cannot handle graphics.

That situation points out a potential problem: new technology can create difficulties for the disabled at the same time that it can make lives easier for them. How can the private sector make sure that new technology does not lock out the disabled but instead makes tasks easier for both the nondisabled and disabled? Accomplishing this will take a combination of business sense and social sensitivity.

Corporations and Research Centers: A Partnership

Corporations also have a unique opportunity: they can work with universities and research laboratories to explore technologies that might benefit the disabled. Examples of such research include robotics, spinal cord stimulation by portable microprocessors, artificial vision by microprocessors and the use of expert systems strategies. Again, there is the possibility that the results of such research will benefit the population in general, not just the disabled.

10.9

Job Training Programs for the Disabled

When companies employ or plan to hire disabled people, effective job preparation programs can assure that jobs are designed with their special needs in mind. For example, communications needs must be considered when working with the hearing-impaired. For many hearing-impaired people, English is not the primary language; their first language is American Sign Language. They may not only need sign-language interpreters, but also have difficulty with written English, since English is not their native language.

Outside the company, training programs can be set up to train people with disabilities for jobs. In that area, companies can provide the technology and people to establish such programs.

Projects with Industry is an example of training centers. Sponsored by the federal government, its goal is to train disabled people for available jobs. As of 1984, one company had trained over 2200 disabled individuals as programmers in more than 30 training centers throughout the United States.

These programs give disabled people an opportunity to learn skills in demand in their particular geographic location. After graduation, they find jobs more quickly because they have skills that employers need.

Media Campaigns

Corporations can also do much to make the general population aware of the disabled community, not as a people with disabilities but as unique individuals with abilities. *10.10*

They can accomplish this objective through media campaigns. One popular McDonald's commercial featured two deaf teenagers, while one for Levi's highlighted an individual in a wheelchair. An IBM print advertisement spotlighting the 1984 International Games for the Disabled commented that there was one thing that IBM's computers couldn't measure at the Games: the determination it took for those individuals to get there in the first place.

Conclusion

What is the young man mentioned in the beginning of this chapter doing now besides his job as a programmer? He didn't let his disabilities hinder him from starting three small companies in addition to his job as a programmer. One provides transportation for disabled persons in the Maryland suburbs of Washington, D.C., a second does construction work, and a third handles a nursing registry. He is also completing his law studies at Georgetown University.

But where would he be if his company had not taken the initial step toward providing accommodations so he could continue working? What if there had been no products available to help him to use computers? This situation emphasizes the fact that technology can enhance the lives of the disabled but that only the private sector makes it available.

It is important to remember, however, that a pragmatic approach is the key in employing, training, and accommodating individuals with disabilities. As previously mentioned, providing a technology that no one can afford accomplishes nothing. Likewise, employers cannot assume that, if they spend a large amount of money on accommodations for disabled employees, they will be properly accommodated. Sometimes simpler accommodations will meet their needs better than the more expensive ones. To avoid overspending, employers should ask their disabled employees what the best accommodations to suit their needs are. For example, many hearing-impaired people do not need sign-language interpreters for meetings, and many visually impaired people do not read braille. Speech recognition systems may not be necessary for quadriplegics if they can use a mouthstick to press keys on the keyboard. The mouthstick is a simple and inexpensive accommodation, yet it can be more effective than a speech recognition system for many disabled individuals. *10.11*

To repeat the beginning sentence of this chapter, corporations have a unique opportunity to expand horizons for disabled people. They can do this by providing the assistance, training, and support needed by the disabled person. Support and assistance should not be given because the law requires it or because it's good for a corporation's public image, but because it's right for society and it's good for business.

Future Trends in Adapted Computer Technology

For disabled students in post-secondary education, the future of adapted computer technology is filled with both promise and peril. Advances in computer technology open some doorways and close (or, more accurately, never really open) others. Over the coming years, careful consideration will be required in the following areas.

Adapted Computer Access to Campus-Wide Networks

In order to harness and organize the vast processing power represented by the array of micro, mini and mainframe computers found on many campuses, colleges are rapidly implementing complex networks which link widely dispersed computer systems into one 11.1 coordinated assemblage whose resources can be shared by all. At their best, such networks become an integral part of the culture of a college or university. Well-designed and functional networks can provide improved student/faculty communications, access to valuable research data, computer assisted or augmented instruction, electronic bulletin board and mail services, a forum for the exchange of information and ideas, access to computerized class registration and much more. Such networks point squarely at the future of information access, not just on college campuses, but in our society as a whole. We are again at a turning point, a critical moment in time at which those with the capacity and opportunity to access vast networks of computerized knowledge will become information rich; those who do not will be information poor. Knowledge, as the saying goes, is power. In our ever-more-complex world, instantaneous computer access to accurate information is the key to knowledge.

It is vitally important that colleges and universities consider the adapted computer access requirements of their disabled students when planning such networks. Failure to do so could inadvertently exclude such students from a major component of campus life and culture.

A number of important questions must be asked:

- **If campus networks are accessed via personal computers, what special equipment and/or software will be required to connect the PC to the campus network?**
- **How will the hardware/software which allows the PC to access the campus network affect the operation of adapted computer access hardware/software?** 11.2
- **Will screen displays of text, on-line card catalogues for example, be consistently formatted to enhance access for blind computer users?**
- **If the campus network makes extensive use of computer graphics, how will access be provided for blind students whose screen reading systems are unable to interpret a graphic display?**
- **What provisions can be made to provide remote access to the network via phone modem by disabled students who may find it more practical to carry out some assignments at home?**
- **If the network can only be accessed with dedicated computer terminals, what provisions will be made to accommodate the special access requirements of blind, low vision or orthopedically disabled students?**

Adapted Access Requirements and Computerized Educational Testing

Most major testing companies (College Board, McGraw/Hill, etc.) now have or are actively developing computerized versions of most tests. Each of these companies shares a common vision of a time in the not-too-distant future when a majority of testing will be conducted in a computerized format. How disabled individuals will be afforded fair and equitable access to such testing environments is an issue which will require careful consideration.

Advanced Computer Graphics and Blind Computer Users

11.3

Recent advances in the technology of extremely high resolution computer displays could have devastating consequences for blind computer users. The trend in the computer industry is toward the development of highly graphic program designs which make extensive use of the display capabilities of advanced computer systems. Such systems replace traditional text oriented program menus and options with graphic symbols called icons. An icon shaped like a computer printer might represent the option to print a document, a tiny trash can the option to erase a program, a small wrist watch the "please wait" prompt. Typically, these options are accessed by directing an on-screen pointer with a pointing device called a mouse. The mouse is rolled about on the surface of the desk or work station until the onscreen pointer is positioned at the desired icon. Pressing a button on the mouse selects the option and typically displays an additional list of icon symbol options. For a sighted computer user struggling with the sometimes cryptic commands used by various programs, such graphically oriented systems can be helpful. For blind computer users, such systems are only now becoming accessible. Given the fundamental methodology screen reading systems employ to translate a visual text display into speech, making graphically oriented computer systems fully accessible to blind users represents an immediate and essential challenge to computer manufacturers and programmers alike.

As the trend in the computer industry appears to be toward the development of such graphically oriented systems, blind computer users are facing the devastating possibility of being denied access to a whole new generation of advanced computer technology. In order to prevent such disasters, it is vitally important that colleges and the computer industry be
11.4 aware of the access requirements of blind computer users. If high resolution, graphically oriented computer systems are the wave of the future, and there are many indications that is indeed the case, an industry-wide standard must be developed to provide access for non-sighted computer users.

How do such design oversights occur? Certainly they do not come about by deliberate action. In most instances, they simply occur through benign neglect. As an example, at a recent conference sponsored by the United States Department of Education, a major university proudly demonstrated a graphically oriented word processing system which they had developed and were proposing as the standard word processor to be used by a consortium of colleges and universities from several states. When asked how they proposed to provide access to blind students the college representative replied "Gee, I guess we didn't think of that." "I guess we didn't think of that" is an all too common refrain which only education and a persistent demand for equal access will begin to remove.

Several major computer manufacturers have already begun to monitor the development of new products with the special access needs of the disabled in mind. IBM, Digital Equipment Corporation and Apple Computer all maintain departments employing specialized staff who oversee new product development with an eye to including product features which assist the disabled computer user and remove those aspects of product design which act as barriers. In many instances, such design modifications benefit the non-disabled user as well. The recent addition by Apple Computer Corporation of access systems for low vision and orthopedically disabled persons to the basic operating system files of Macintosh computers is an outstanding example of responsible leadership on the part of computer manufacturers. 11.5

Access to Publicly Funded Computer Databases

A vast amount of publicly available information is stored in computerized databases established and maintained by federal dollars. These databases are, in effect, enormous public libraries of an entirely new order. They are the future of information storage and retrieval. Access to these resources will clearly separate the information-rich members of our society from the information-poor. It is very important that the computer access requirements of disabled persons be clearly understood and responded to in order to maintain equal access to this wealth of computerized information.

Although of an entirely new order, computerized libraries are in many respects much like traditional libraries. There users may still browse through titles, opening an electronic book here and there to scan an area of interest. The fundamental difference is the incredible speed with which such electronic browsing can be carried out. A complete literature search for a doctoral thesis might be completed in less than one hour.

These are indeed public libraries, funded by federal dollars, intended for the use of all citizens and therefore subject to the provisions of the Architectural Barriers Removal Act of 1968 which states that access for disabled individuals must be provided to any building maintained through the receipt of federal dollars or to buildings used by organizations receiving federal dollars. The advent of advanced technologies will require reevaluation of our traditional view of access in *11.6* light of the creation of federally funded "electronic environments" which may only be entered via computer.

Emerging Technologies and Adapted Computer Access

At least three research areas have begun to produce results which hold enormous potential benefit for disabled computer users: optical character recognition, speech recognition and direct visual selection.

Optical character recognition is a process through which a printed document, a business letter for example, can be automatically converted to a computerized text file editable by any standard word processor. For blind, low vision and learning disabled individuals, this would be most useful. Optical character readers, often called OCRs, are external hardware devices about the

size of a typical computer printer. A sheet of paper containing the written materials to be converted is fed into the OCR. Printed content is examined letter by letter and converted to a computerized text file. On average, the process requires two to four minutes per page and is generally around 98% accurate. During the conversion process, if the OCR encounters a symbol it doesn't recognize, the user is notified and given the opportunity to insert the correct choice. Alternately, most OCRs will also substitute a previously agreed upon character, a question mark for example, in place of any character or symbol in the printed document it is unable to recognize. The majority of OCRs recognize a variety of type styles and sizes, and several can be "trained" to recognize a good many more. Currently, recognition accuracy is significantly affected by quality, style and size of printed characters as well as page formatting. As an example, a document composed in block paragraph style using a 10 pitch Courier type font printed on a laser or letter quality printer would probably be read by the average OCR with no errors. The same document printed on a dot matrix printer would probably be read by the OCR with a 3% error rate. The improvements in OCR technology have been rapid and dramatic. It is reasonable to expect that within the next year or two, continuing advances in the accuracy and reliability of OCRs coupled with continued price reductions will make this device an important tool for providing adapted computer access. *11.8*

Although speech recognition technology has been commercially available for several years, fundamental limitations in accuracy and reliability of even the best speech recognition systems produced by lack of microcomputer processing speed and memory access have rendered such devices impractical for use by orthopedically disabled, learning disabled or blind individuals. The ideal adaptation for such individuals, the mythical "talking typewriter," may finally be on the technological horizon. Such a device would accept spoken input at a normal rate of speech, convert everything it "heard" into a computerized text file, insert punctuation marks, correct spelling, suggest grammatical alterations and finally, if desired, print the document. With the advent of new, very high speed microcomputers capable of performing millions of tasks per second and addressing billions of bytes of internal memory, a computer environment now exists which is capable of supporting the dual requirements of such systems: raw processing power and memory. Because such a device would be of great interest to the general public, it is well within the realm of possibility that highly reliable, entirely speech activated word processing systems will be commercially available at a reasonable price within the next two to three years. Such systems will revolutionize computer access for orthopedically disabled, learning disabled and blind individuals.

11.9 Work in the area of direct visual selection could be of unprecedented benefit to severely orthopedically disabled persons. Individuals who because of the scope and severity of their disability are unable to produce intelligible speech and have no gross or fine motor control; individuals who have been virtual prisoners within their own bodies may soon have access to some extraordinary new access technologies. Direct visual selection allows such persons to "type" by simply looking at the letter they wish to select.

There are two major lines of development in the area of direct visual selection. The first involves the use of a keyboard-like device, specialized video camera and infrared reference beam; the second incorporates a system which reads selection data directly from the optical cortex of the brain.

The system, incorporating an on-screen keyboard, specialized video camera and reflector, is a commercially available product. Although it has requirements which make it unusable by many severely orthopedically disabled persons, it points the way toward development of much more broadly effective devices incorporating the same basic technology. A particular liability of the system is its requirement that the user be able to hold his/her head very still while selecting characters from the on-screen keyboard. If the user is able to meet this requirement, the system behaves exactly like the computer's keyboard and can be used with either Macintosh or PC type computers.

A second line of development takes an entirely different approach and may be much more broadly applicable to the computer access requirements of the severely orthopedically disabled. Not yet a commercially available product, this system reads the electrical activity of the brain's optical cortex. In use, tiny sensors are placed on the scalp over the optical cortex. The user looks at a keyboard-like device, each "key" of which has a small, bright light which blinks at a different 11.10 rate. The user simply looks at the key he/she wishes to select. The system reads the blink rate of the light directly from the electrical activity of the optical cortex, identifies the key associated with the blink rate and sends the correct character to the computer. The system is much more tolerant of head motion and nastagmus (a rapid, involuntary, horizontal movement of the eye). Although still experimental, the technology appears to be quite reliable and hopefully will appear as a commercially available product within the next year or two.

Adapted Computer Access and the 1986 Amendments to the Rehabilitation Act of 1973

With the 1986 amendments to the Rehabilitation Act of 1973, new language was included which will have a dramatic effect on the future of computer access for hundreds of thousands of disabled persons. Broadly referred to as "electronic curb cut legislation," when fully implemented, the impact of these new access requirements will be of enormous benefit. Although initially referenced in Chapter 8, because of its importance to the future of adapted computer technology, it seems only fitting to conclude this work with the language of the amendment in its entirety:

> Title V. Miscellaneous
>
> A new section (508) Electronic Equipment Accessibility has been added.
>
> Sec. 508.(a) (1) The Secretary through the National Institute on Disability and Rehabilitation Research and The Administrator of the General Services, in consultation with the electronics industry, shall develop and establish guidelines for electronic office equipment with or without special peripherals. 11.11
>
> (2) The guidelines established pursuant to paragraph (1) shall be applicable with respect to electronic equipment, whether purchases or leased.
>
> (3) The initial guidelines shall be established not later than October 1, 1987, and shall be periodically revised as technologies advance or change.
>
> (b) Beginning after September 30, 1988, the Administrator of General Services shall adopt guidelines for electronic accessibility established under subsection (a) for Federal procurement of electronic equipment. Each agency shall comply with the guidelines adopted under this subsection.
>
> (c) For the purpose of this section, the term special peripherals means a special needs aid that provides access to electronic equipment that is otherwise inaccessible to a handicapped individual.

The committee, formed under the auspices of the National Institute of Handicapped Research to establish access guidelines for electronic office equipment is called The White House Committee for Equal Access to Standard Computers and Information Systems.

Product Guide to Adapted Computer Hardware and Software

Introduction

The following pages detail computer adaptations available as of November, 1988. There have been significant improvements and additions to the access systems described in the first edition of this book. As with all rapidly advancing technologies, many of the programs and devices described here will likely (within a year or two) be replaced by even more efficient adaptations. Remember, however, the distinction made in the introductory chapter of this work between technological and functional obsolescence. Barring some truly radical and totally unexpected breakthrough in computer science, the majority of the adaptations listed here should remain functionally efficient for the next three to five years.

The products listed here meet or exceed the access criteria described in the preceding chapters. They have been thoroughly tested and have proven to be highly reliable and effective. These adaptations are by no means the only systems available; they simply represent an array of hardware and software adaptations which do work. Use them as a starting point from which you can be confident of success and then, if you are so inclined, begin to explore new and perhaps even better ways of providing adapted computer access.

Even though many dramatic gains have been made, much work remains to be done. Although excellent, software-based, large print systems for the Apple Macintosh computer have recently been developed, no one as yet has introduced a first rate system for PC-type computers which is based entirely in software. Screen reading systems for blind users, at their best, are still somewhat cumbersome and difficult to use. Speech synthesizers based entirely in software which emulate DECtalk or Votrax systems are just beginning to appear. Software-based keyboard control programs for the Macintosh have become a reality since the first edition of this book, as have word anticipation/completion utilities which will function with any word processor on either Macintosh or PC computers; and the list goes on.

Clearly there is ample room to add many more adaptations to those listed here. It is our most profound hope that the following equipment represents an expansion of our first list rather than its completion.

Adaptations for Low Vision Computer Users

Product Name: Close View
Vendor: Apple Computer Corporation

Address: 20525 Mariani Avenue
Cupertino, California 95014
Telephone: (408) 996-1010

Price: N/C

Used With: Apple Macintosh Plus, SE and II

Special Considerations: Included with the Apple Macintosh operating system versions 6.0 and higher. Can be launched automatically at system start-up or selected. Provides 2X to 16X degrees of magnification. Transparent to most applications programs, easy to use, fast text handling. Although providing no single line display or scrolling options, Close View may be all the help many low vision Macintosh users need.

Notes: The auto-launch method may prove inconvenient if the system is to be used by other than low vision persons.

Product Name: inLARGE
Vendor: Berkeley System Design

Address: 1700 Shattuck Avenue
Berkeley, California 94709-1720
Telephone: (415) 540-5537

Price: $95.00

Used With: Apple Macintosh Plus, SE and II

Special Considerations: InLARGE is a memory resident program which appears to be transparent to other applications programs. Magnification is adjustable between 1X and 16X. The program provides single line display, scrolling and cursor tracking. All commands are given at the keyboard. Text move-display is fast and smooth. Works with communications software (although enlarged text will tend to be displayed in "spurts," nothing will be lost). All commands are issued through keys on the Macintosh keyboard. Adjustable scrolling rates, overview mode and black-on-white or white-on-black text display option. Automatic cursor tracking with all programs. InLARGE can be used in an Ethernet environment with Digital Equipment Corporation systems.

A.4

Notes: Close View, a large print system provided by Apple Corporation with versions 6.0 and greater of the Macintosh operating system is a sub-set of the inLARGE program licensed to Apple by Berkeley System Design. B.S.D. is planning to release a screen reading system for the Macintosh (Outspoken) in the spring of 1989.

Product Name: NicePrint
Vendor: Spies Laboratories

Address: 4040 Spencer Street, Suite Q
Torrance, California 90503
Telephone: (213) 538-8166

Price: $95.00

Used With: IBM PC, XT, AT, PS/2 or work-alike and IBM Graphics printers, Epson printers with Graftrax or work-alikes

Special Considerations: Produces legal size (25 point) large print on dot matrix printers. Best results are obtained using a wide carriage (132 column) printer. The document to be printed in large print must be no more than 65 characters wide. The left print margin should be set to 0. For wider documents, the program provides a "sideways" option which rotates the text 90 degrees. A cautionary note: NicePrint is a memory resident program; if the program is currently in memory, loading it in a second time will cause a malfunction.

Notes: Provides an excellent method for producing large print output on paper. Provides a wide selection of large print font styles, is easy to install and use and appears to work with most programs which produce printed text. Even with high-speed printers, the program will require approximately three times longer to print a full page of large print text. Large print text is clearly formed, even on 9 pin dot matrix printers.

Product Name: PC Lens
Vendor: Arts Computer Products, Inc.

Address: 145 Tremont Street, Suite 407
Boston, Massachusetts 02111
Telephone: (617) 482-8248

Price: $690.00

Used With: IBM PC, XT, AT and other 100% PC compatible computers using 100% PC compatible monochrome and color graphics adapter boards

Special Considerations: PC Lens is a software program which requires a monochrome display board, a color display board and a color monitor in order to function. If the existing computer system currently has a compatible color display board and color monitor, a monochrome display board can be purchased for around $250-300 bringing the actual cost of PC Lens to approximately $800. If the existing computer system does not have a compatible color display board and color monitor, purchase of additional needed equipment will bring the actual cost of PC Lens to around $1300. Additionally, a switch within the computer will need to be set to allow both the monochrome and color boards to function simultaneously. Does not currently work with the IBM PS/2.

Notes: PC Lens displays text only. Once the various color and monochrome boards have been installed, the program is relatively easy to learn and use. PC Lens makes extensive use of Ctrl and function key combinations to carry out its various options. Four levels of magnification are provided starting at 2X and increasing to approximately 12X. PC Lens provides a variety of interesting options including control of text display color, spacing between letters, words and lines, automatic cursor tracking and an overview mode. When scrolling vertically or horizontally, text display often becomes ragged and "jerky." On computers with faster processing speeds like the PC AT, screen displays are somewhat smoother. As with the VISTA system, automatic cursor tracking works with all programs except spreadsheets. Due to the slow speed at which screens of large print are displayed, PC Lens is unable to function satisfactorily with communications software and terminal emulators.

Product Name: VISTA, VISTA 2
Vendor: TeleSensory Systems, Inc.

Address: 455 North Bernardo Avenue
Mountain View, California 94043
Telephone: (415) 960-0920

Price: VISTA (Model SF1B) $2095.00
VISTA 2 (Model SF2A) $2495.00

Used With: IBM PC, XT, AT, PS/2 models 30, 50 and 60 (50 and 60 require VISTA 2), HP Vectra, and 100% PC compatible computers with 100% PC compatible monochrome, CGA, EGA or VGA video display boards

Special Considerations: The VISTA system is an internal hardware device. It takes up one slot inside the computer. Uses a mouse pointer which requires a 25 pin serial port. Most PC type computers come with a built-in serial port, but a port is simple and inexpensive ($40-50) to add if needed. Check with vendor before purchase to confirm compatibility of equipment with which VISTA will be used.

Notes: Works well with both text and graphics. Easy to install, learn and use. Magnification adjustable from 3X to 11X (2X to 14X with VISTA 2). Large print text display is fast and smooth. Works with communications software (modems), many computer networks and terminal emulators. All commands are issued using the buttons on the mouse pointer. Adjustable scrolling rates, optional single line display, overview mode and optional pre-set start-up settings for various display options are standard features. Automatic cursor tracking with all programs except spreadsheets. Viewing window must be manually relocated when using VISTA with spread sheet type programs (i.e., Lotus, Multiplan, SuperCalc). Only PC based large print system presently meeting Section 508 guidelines.

Adaptations for Blind Computer Users

Product Name: DECtalk
Vendor: Digital Equipment Corporation

Address: 129 Parker Street
Maynard, Massachusetts 01754
Telephone: (617) 897-5111

Price: $4000.00 ($1600.00 with grant)

Used With: IBM PC, XT, AT, PS/2 or work-alikes, Apple, or any system which uses a serial port to output to the speech synthesizer

Special Considerations: The serial cable connecting the computer to the DECtalk will most likely need to be reconfigured to accommodate the serial output requirements of your computer. This will definitely be the case with all PC and PC work-alike type computers. Before purchasing a DECtalk, be certain the screen reading system with which it will be used supports the DECtalk speech synthesizer. Almost all screen readers for PC computers will; screen readers for Apple computers or other types of computers may not.

A.10

Notes: Clearly the best speech synthesizer currently available. DECtalk's speech production is non-robotic, clear, distinct and easily understandable by all users. Distinctions between the letters D, B, C, and V are easily heard. DECtalk provides several unique voices, adjustable speech rates, methods for making adjustments to various aspects of speech production, external volume control, headphone jack and a wealth of additional features. The unit is extremely well made and will provide years of trouble-free service.

Product Name: Freedom 1
Vendor: Interface Systems International

Address: P.O. Box 20415
Portland, Oregon 97220
Telephone: (503) 256-2036

Price: $499.00

Used With: IBM PC, XT, AT, PS/2 or work-alikes

Special Considerations: Sophisticated macro capability allows for a high level of integration between the screen review mode and the applications mode. In operation, the user is able both to read the screen and use the application (i.e., word processor, bookkeeping program, spreadsheet) at the same time. The program comes with predefined macros for several popular programs. Additional macro sets may be created using a procedure which, although exacting, is not particularly difficult. The ease of use afforded by Freedom 1's macros make it a good choice for a broad range of purposes including use by learning disabled and non-oral persons. Freedom 1 can be used concurrently with the VISTA system to produce talking large print.

A.12

Notes: Meets all the basic criteria for a good screen reading system. Allows the user to work efficiently. Reads letters, words, lines, multiple lines and complete sentences. Supports windows, announces computer generated screen changes and text colors, and supports "military" designations of letters (Alpha for A, Bravo for B, etc.). Reads forward or backward. Sets of predefined macros can be loaded which configure Freedom 1 to work with the program in use. Makes full use of most standard speech synthesizers. All program options are announced verbally. Operates very quickly and uses a small amount of computer memory. Freedom 1 supports some terminal emulation programs. Check with the vendor for more exact information.

Product Name: Screen Reader

Vendor: IBM
National Support Center for
the Disabled

Address: P.O. Box 2150
Atlanta, Georgia 30055

Telephone: (800) 426-2133

Price: $630.00

Used With: All IBM PS/2 series computers

Special Considerations: Screen Reader works exclusively on PS/2 or fully compatible systems and employs a small keypad attached to the game port. All screen reading commands are issued from the Screen Reader keypad. Screen reading capability is always available as there is no review mode as such. The system works with most brand name speech synthesizers (i.e., DECtalk, CallText, Artic, Votrax, etc.) and, in addition to general full screen reading capability, provides specialized reading templates for many major software applications. Screen Reader provides the reading options found in most high-end systems plus a built-in help function which provides spoken messages explaining all of the available options. Screen Reader is fast, transparent and easy to learn. Additionally, the second keypad assures that there will never be a conflict in key usage between screen reading and applications software.

Notes: Although Screen Reader comes with reading templates for many widely used applications programs (i.e., WordPerfect, WordStar, dBASE, Lotus, etc.), developing new templates is done through the quite complicated Screen Reader programming language and compiler. Developing new templates is not a trivial undertaking and will require a programmer's skills. IBM expects that in time, a library of reading templates will be developed, thus eliminating most needs to use the programming language.

Product Name: Soft Vert
Vendor: TeleSensory Systems, Inc.

Address: 455 North Bernardo Avenue
Mountain View, California 94043
Telephone: (415) 960-0920

Price: $495.00

Used With: IBM PC, XT, AT, PS/2 or work-alikes

Special Considerations: An excellent system for reading complex screen displays like reservations systems, spreadsheets, accounting programs, etc. Soft Vert provides a variety of specialized options which can be of great value when used in conjunction with terminal emulation programs. Although providing some ability to read the screen while remaining in the application, to fully access the extensive review capability of Soft Vert the user must leave the application program and enter the review mode.

Notes: Meets all the basic criteria for a good screen reading system. Allows the user to work efficiently. Reads letters, words, lines, multiple lines and complete sentences. Supports windows, announces computer generated screen changes and text colors, and supports "military" designations of letters (Alpha for A, Bravo for B, etc.). Reads forward or backward. User defined program configurations can be saved and reloaded. All program options are announced verbally. Uses most standard speech synthesizers, operates at an acceptable rate of speed and uses a moderate amount of computer memory. Soft Vert supports several terminal emulation programs. Check with the vendor for more exact information. Because of its extensive and quite sophisticated review capabilities, this program is a good choice for blind computer programmers and other blind professionals who require great flexibility in a screen reading program.

Product Name: Votrax Personal Speech Synthesizer
Vendor: Votrax Corporation

Address: 1358 Rankin
Troy, Michigan 48083
Telephone: (800) 521-1350

Price: $449.00

Used With: IBM PC, XT, AT, PS/2 or work-alikes, Apple, or any system which uses a serial or parallel port to output to the speech synthesizer

Special Considerations: When ordering this device, be sure to specify what type of computer it will be used with, the screen reading program to be used and whether a serial or parallel port will be used for speech output. Before purchasing a PSS, be certain the screen reading system with which it will be used supports the Votrax speech synthesizer. Almost all screen readers will but it never hurts to check.

Notes: Votrax is one of the oldest and most reliable manufacturers of low cost speech output devices. Votrax speech production is somewhat robotic, and learning to hear distinctions between such letters as D, B, C, and V takes some practice. Interestingly enough, blind users who have become familiar with the pronunciation style of the Votrax sometimes prefer it to the DECtalk. Votrax provides adjustable speech rates, external volume control, headphone jack and a number of additional features. The unit is a good choice for low cost speech output. The quality and accuracy of Votrax speech production are such that it should not be used with learning disabled students.

Adaptations for Orthopedically Disabled Computer Users (Mild to Moderate)

Product Name: Adaptive Firmware Card
Vendor: Adaptive Peripherals

Address: 4529 Bagley Avenue North
Seattle, Washington 98103
Telephone: (206) 633-2610

Price: $300.00 (Apple II +), $350.00 (Apple IIe)

Used With: Apple II + and IIe computers

Special Considerations: The Adaptive Firmware Card is a plug in board which is used to alter the normal behavior of the Apple computer and keyboard. Programming the card, although not particularly difficult, is an exacting procedure which does require some practice.

Notes: The Firmware card has a variety of capabilities designed to make the Apple computer and keyboard more accessible to orthopedically disabled persons. Automatic key repeat may be turned on or off, Shift, Esc, Apple and Ctrl keys can be electronically latched or unlatched to facilitate ease of use by one-finger typists. The Firmware card can store and recall multiple keyboard configurations, slow down the speed at which information is displayed on the computer screen and also accept keyboard input in the form of Morse Code. The card also provides auxiliary inputs for special keyboards and single switch devices.

Product Name: Easy Keys/Mouse Keys
Vendor: Apple Computer Corporation

Address: 20525 Mariani Avenue
Cupertino, California 95014
Telephone: (408) 996-1010

Price: N/C

Used With: Apple Macintosh Plus, SE, and II

Special Considerations: Provided at no charge with versions 5.0 and greater of the Macintosh operating system. Easy Keys has many of the capabilities of Filch. It provides electronic latching of all "special" keys on the Macintosh keyboard (i.e., Open Apple, Ctrl, Shift, etc.). The system provides both "latch/release" and "continuous latch" options. Key repeat rate and visual cueing of auditory prompts can also be selected using the control panel. Mouse Keys allows all mouse functions to be controlled using the arrow and numeric keys on the Macintosh enhanced keyboard. In combination with Easy Keys, all mouse functions can be duplicated at the keypad. Icons appearing in the upper right corner of the screen prompt the user to latched or shifted keys.

Notes: Easy Keys, Mouse Keys and Close View are excellent examples of the industry trend to incorporate access systems directly into the operating system. Although each of these systems still require a little fine tuning, they are quite functional as they are and may well meet the access needs of many orthopedically or visually disabled persons.

Product Name: Filch
Vendor: Kinetic Designs

Address: 14231 Anatevka Lane, S.E.
Olalla, Washington 98359
Telephone: (206) 857-7943

Price: $89.00

Used With: IBM PC, XT, AT, PS/2 or work-alikes

Special Considerations: When used in combination with other programs, version 2.0 of Filch must be loaded before any other applications.

Notes: A basic tool for providing keyboard access to orthopedically disabled persons. The program is easy to use and provides a wide variety of methods for altering the normal behavior of the PC keyboard. Automatic key repeat can be slowed down or turned off completely: Ctrl, Alt, and Shift keys can be electronically latched on or off to facilitate use by one- finger typists; an "electronic keyguard" feature desensitizes the keyboard and reduces the incidence of accidental keystrokes by persons with limited fine motor control; a user definable display window shows the status (latched or unlatched) of the Ctrl, Alt, or Shift keys. Filch also includes a wealth of other additional features. Keyboard configuration options can be automatically carried out when the program is started. Filch is entirely memory resident, occupies around 1200 bytes and seems to work with almost all software. Keyboard configuration options may be selected individually or in any combination.

Product Name: Gramatik III
Vendor: Reference Software

Address: 330 Townsend Street, Suite 123
San Francisco, California 94107
Telephone: (800) 872-9933

Price: $99.00

Used With: IBM PC, XT, AT, PS/2 and work-alike computers

Special Considerations: Grammar and usage checkers in the microcomputer environment are still in their technological infancy and, although Gramatik III is no exception, it represents the best of what is currently available. Like most grammar and usage checkers, its comments are often either overly generalized or excessively "picky." Its most useful application remains the identification of gross errors in capitalization, some types of punctuation and word usage.

Notes: Gramatik III is a grammar and usage checker. It identifies missing punctuation marks, vague or hackneyed word usage, cumbersome phrasing, sexist terminology, run-on sentences, missing capitalizations and a variety of other grammatical and stylistic errors. The program is able to insert comments directly into the document, display them on the computer screen or print them. Gramatik displays the portion of the document in which the error occurred and makes suggestions for corrective action. Although of some value for students with learning disabilities, the program is most profitable used in conjunction with instructional staff who can explain the sometimes vague and pedantic critiques generated by Gramatik III.

Product Name: Keytronics KB 5153 Keyboard for the Disabled

Vendor: Keytronics

Address: P.O. Box 14687
Spokane, Washington 99214

Telephone: (509) 928-8000

Price: $400.00

Used With: IBM PC, XT, AT or work-alikes

Special Considerations: Changes in the design of the keyboard port on the IBM PS/2 computers have rendered the KB 5153 keyboard non-compatible as of this writing. Use this or any alternative keyboarding system only in instances where the advantages clearly outweigh the problem of replacing the factory issue computer keyboard.

Notes: In addition to the usual keys found on the standard PC keyboard, the KB 5153 provides a touch sensitive tablet with 36 programmable locations. Lengthy command sequences may be stored at each of these locations and executed with a single touch. The KB 5153 comes with preprogrammed set-ups and templates for many commonly used software programs (WordPerfect, Lotus, dBASE, WordStar, etc.); others can easily be created and saved for future use. The normal size of the touch sensitive area on the pad can be increased from approximate 0.75 x 0.75 inches per location to a maximum of 2.5 x 2.5 inches per location. This can be a valuable feature for orthopedically disabled persons with limited fine motor control. As the size of the touch sensitive location is increased, however, the number of touch sensitive locations is reduced. The KB 5153 can be of value to orthopedically and learning disabled students as well as to persons with acquired brain injuries.

Product Name: MindReader
Vendor: Brown Bag Software

Address: 2155 South Bascom Avenue, Suite 114
Campbell, California 95008
Telephone: (408) 559-4545

Price: $89.95

Used With: IBM PC, XT, AT, PS/2 or work-alikes

Special Considerations: MindReader requires 256K of memory and works with either monochrome, color or enhanced graphics displays. When used in combination with other software based adaptations, additional computer memory will be required. Computers equipped with 640K of memory will support MindReader and several other adaptations concurrently.

Notes: MindReader is a "smart" word processor which is able to anticipate and complete words or phrases based on their first few letters. Used with persons who have limited fine motor control, MindReader can increase typing speed by as much as 75%. The system is entirely menu driven. Most individuals are able to produce printed documents within thirty minutes after being introduced to the program. MindReader "learns" a user's word usage patterns and so becomes "smarter" with continued use. The size of MindReader's vocabulary is only limited by disk storage space. The program is a full-featured word processor including a calculator, spelling check and line drawing capability. MindReader can produce a standard ASCII text file which can be used by other word processing programs. All processing is performed in memory, so the number of pages which can be edited at any one time will be determined by available memory. A typical computer system with 256K of memory should be able to handle a 25 to 30 page document.

Product Name: Turbo Lightning
Vendor: Borland International

Address: 1700 Green Hill Road
Scotts Valley, California 95066-0001
Telephone: (408) 438-8400

Price: $99.95

Used With: IBM PC, XT, AT, PS/2 or work-alikes

Special Considerations: Requires plenty of disk storage and, when used in conjunction with other software based adaptations, a computer with 640K of memory. Although it continues to function, Turbo Lightning loses some flexibility when used with non-standard programs like Mind Reader. Although non-standard programs do not appear on the Turbo Lightning installation menu, with a little experimentation almost any program can be accommodated. When using the program with a two floppy drive system, best results will be obtained by placing the program and thesaurus files on drive A: and the dictionary files on drive B:.

Notes: Turbo Lightning is a "real-time" spell check and thesaurus. That is, it checks spelling as text is actually being entered. A tone alerts the user to probable spelling errors as they actually occur. Pressing a single key causes Turbo Lightning to display a window of likely correct spellings. Word corrections are based on sound alike words rather than similarly spelled words. For example, the incorrectly

spelled word "psikologist" would still cause Turbo Lightning to suggest the correct spelling of "psychologist" because of the sound alike quality of both words. Placing the cursor on a word in the document and pressing a single key causes a list of synonyms to be displayed. Word replacement is completely automatic for both the spell checker and thesaurus. New words can be added to the spell checker's dictionary but not to the thesaurus.

Adaptations for Orthopedically Disabled Computer Users (Moderate to Severe)

Product Name: Long Range Optical Pointer
Vendor: Words +, Inc.

Address: P.O. Box 1229
Lancaster, California 93534
Telephone: (805) 949-9331

Price: $995.00

Used With: IBM or compatible

Special Considerations: Originally used with two monitors but has recently been redesigned for use with one monitor. As the optical pointer is directed toward the screen, the keyboard appears. The application screen appears when the pointer is moved away from the screen.

Notes: Provides accurate, efficent access to standard software using head control or other controllable sites to aim an optical pointer. Also provides acceleration techniques, including direct selection of most frequently used words, word prediction and automatic word endings.

Product Name: Mini Keyboard
Vendor: Tash

Address: 70 Gibson Drive, Unit 12
Markham, Ontario, Canada L3R 4C2
Telephone: (416) 475-2212

Price: $325.00

Used With: Apple IIe, Apple IIGS, IBM or compatible

Special Considerations: The Mini Keyboard must be used with a keyboard emulator such as the Adaptive Firmware Card in the expanded keyboard mode or the PC Serial A.I.D. for IBM.

Notes: A small keyboard with closely spaced membrane keys. Requires very little force to activate the keys (100 gms). Force to activate can be provided by pointers including the fingers, a handheld pointer, a headwand or a mouthstick. Is used when there is a small range and fine resolution. Can be used to reduce the effort required to move between keys that would otherwise be positioned farther apart on a standard keyboard. Layout of keyboard can be redefined with letters, words, functions or phrases using the keyboard emulators. Keyguard available.

Product Name: RealVoice/EvalPac/ScanPac
Vendor: Adaptive Communication Systems, Inc.

Address: 354 Hookstown Grade Road
Clinton, Pennsylvania 15026
Telephone: (412) 264-2288

Price: $2695.00 to $3995.00

Used with: IBM compatibles, Apple II

Special Considerations: Requires a keyboard emulation interface such as the ACS Emulator for the Apple IIe, Adaptive Firmware Card or the Prentke Romich Keyboard Interface for the Apple II or IBM PC and compatibles.

Notes: A portable augmentative communication system that can be accessed by scanning, light pointer, expanded keyboard, joystick and Morse Code. Capable of storing key words and phrases using abreviations or locations. Uses a very high quality female or male voice output for spoken communication.

Product Name: Touch Talker/Light Talker
Vendor: Prentke Romich Company

Address: 1022 Heyl Road
Wooster, Ohio 44691
Telephone: (216)262-1984

Price: $2895.00 to $4290.00

Used with: IBM compatibles, Apple II

Special Considerations: Requires a keyboard emulator such as the Adaptive Firmware Card with the Apple II or the Prentke Romich Company Keyboard Emulator with Apple II or IBM and compatibles.

Notes: These are portable, speech output, augmentative communications systems. The Touch Talker is accessed with a keyboard. The Light Talker is accessed with an optical pointer, switches and scanning, and Morse Code. Key words and phrases can be stored and retrieved using a picture encoding strategy, Minspeak, or levels and locations.

Product Name: Unicorn Expanded Keyboard
Vendor: Unicorn Engineering Company

Address: 6201 Harwood Avenue
Oakland, California 94618
Telephone: (415) 428-1626

Price: $425.00

Used With: Apple IIe, Apple II GS, IBM or compatible

Special Considerations: Requires a keyboard emulator such as the Adaptive Firmware Card in the expanded keyboard mode for Apple or the PC Serial A.I.D. for IBM.

Notes: A large membrane keyboard with 128 activation sites. Each activation site is ¾″ x ¾″ with the centers 2 inches apart. Custom keyboard layouts are easily created and changed using overlays and the keyboard emulators. Activation sites can be defined as letters, words, functions or phrases and can be combined for larger target areas. The Unicorn Expanded Keyboard is useful with a large range and fine or gross resolution. 64-hole and 128-hole keyguards available.

Adaptations for Learning Disabled Computer Users

Product Name: DECtalk
Vendor: Digital Equipment Corporation

Address: 129 Parker Street
Maynard, Massachusetts 01754
Telephone: (617) 897-5111

Price: $4000.00 ($1600.00 with grant)

Used With: IBM PC, XT, AT, PS/2 or work-alikes, Apple, or any system which uses a serial port to output to the speech synthesizer

Special Considerations: The serial cable connecting the computer to the DECtalk will most likely need to be reconfigured to accommodate the serial output requirements of your computer. This will definitely be the case with all PC and PC work-alike type computers. Before purchasing a DECtalk, be certain the screen reading system with which it will be used supports the DECtalk speech synthesizer. Almost all screen readers for PC computers will; screen readers for Apple computers or other types of computers may not.

Notes: Clearly the best speech synthesizer currently available. DECtalk's speech production is non-robotic, clear, distinct and easily understandable by all users. Distinctions between the letters D, B, C, and V are easily heard. DECtalk provides several unique voices, adjustable speech rates, methods for making adjustments to various aspects of speech production, external volume control, headphone jack and a wealth of additional features. The unit is extremely well made and will provide years of trouble-free service.

Product Name: Freedom 1
Vendor: Interface Systems International

Address: P.O. Box 20415
Portland, Oregon 97220
Telephone: (503) 256-2036

Price: $499.00

Used With: IBM PC, XT, AT, PS/2 or work-alikes

Special Considerations: Sophisticated macro capability allows for a high level of integration between the screen review mode and the applications mode. In operation, the user is able both to read the screen and use the application (i.e., word processor, bookkeeping program, spreadsheet) at the same time. The program comes with predefined macros for several popular programs. Additional macro sets may be created using a procedure which, although exacting, is not particularly difficult. The ease of use afforded by Freedom 1's macros make it a good choice for a broad range of purposes including use by learning disabled and non-oral persons. Freedom 1 can be used concurrently with the VISTA system to produce talking large print.

Notes: Meets all the basic criteria for a good screen reading system. Allows the user to work efficiently. Reads letters, words, lines, multiple lines and complete sentences. Supports windows, announces computer generated screen changes and text colors, and supports "military" designations of letters (Alpha for A, Bravo for B, etc.). Reads forward or backward. Sets of predefined macros can be loaded which configure Freedom 1 to work with the program in use. Makes full use of most standard speech synthesizers. All program options are announced verbally. Operates very quickly and uses a small amount of computer memory. Freedom 1 supports some terminal emulation programs. Check with the vendor for more exact information.

Product Name: Gramatik III
Vendor: Reference Software

Address: 330 Townsend Street, Suite 123
San Francisco, California 94107
Telephone: (800) 872-9933

Price: $99.00

Used With: IBM PC, XT, AT, PS/2 and work-alike computers

Special Considerations: Grammar and usage checkers in the microcomputer environment are still in their technological infancy and, although Gramatik III is no exception, it represents the best of what is currently available. Like most grammar and usage checkers, its comments are often either overly generalized or excessively "picky." Its most useful application remains the identification of gross errors in capitalization, some types of punctuation and word usage.

Notes: Gramatik III is a grammar and usage checker. It identifies missing punctuation marks, vague or hackneyed word usage, cumbersome phrasing, sexist terminology, run-on sentences, missing capitalizations and a variety of other grammatical and stylistic errors. The program is able to insert comments directly into the document, display them on the computer screen or print them. Gramatik displays the portion of the document in which the error occurred and makes suggestions for corrective action. Although of some value for students with learning disabilities, the program is most profitable used in conjunction with instructional staff who can explain the sometimes vague and pedantic critiques generated by Gramatik III.

Product Name: MindReader
Vendor: Brown Bag Software

Address: 2155 South Bascom Avenue, Suite 114
Campbell, California 95008
Telephone: (408) 559-4545

Price: $89.95

Used With: IBM PC, XT, AT, PS/2 or work-alikes

Special Considerations: MindReader requires 256K of memory and works with either monochrome, color or enhanced graphics displays. When used in combination with other software based adaptations, additional computer memory will be required. Computers equipped with 640K of memory will support MindReader and several other adaptations concurrently.

Notes: MindReader is a "smart" word processor which is able to anticipate and complete words or phrases based on their first few letters. Used with persons who have limited fine motor control, MindReader can increase typing speed by as much as 75%. The system is entirely menu driven. Most individuals are able to produce printed documents within thirty minutes after being introduced to the program. MindReader "learns" a user's word usage patterns and so becomes "smarter" with continued use. The size of MindReader's vocabulary is only limited by disk storage space. The program is a full-featured word processor including a calculator, spelling check and line drawing capability. MindReader can produce a standard ASCII text file which can be used by other word processing programs. All processing is performed in memory, so the number of pages which can be edited at any one time will be determined by available memory. A typical computer system with 256K of memory should be able to handle a 25 to 30 page document.

Product Name: Turbo Lightning
Vendor: Borland International

Address: 1700 Green Hill Road
Scotts Valley, California 95066-0001
Telephone: (408) 438-8400

Price: $99.95

Used With: IBM PC, XT, AT, PS/2 or work-alikes

Special Considerations: Requires plenty of disk storage and, when used in conjunction with other software based adaptations, a computer with 640K of memory. Although it continues to function, Turbo Lightning loses some flexibility when used with non-standard programs like Mind Reader. Although non-standard programs do not appear on the Turbo Lightning installation menu, with a little experimentation almost any program can be accommodated. When using the program with a two floppy drive system, best results will be obtained by placing the program and thesaurus files on drive A: and the dictionary files on drive B:.

Notes: Turbo Lightning is a "real-time" spell check and thesaurus. That is, it checks spelling as text is actually being entered. A tone alerts the user to probable spelling errors as they actually occur. Pressing a single key causes Turbo Lightning to display a window of likely correct spellings. Word corrections are based on sound alike words rather than similarly spelled words. For example, the incorrectly

spelled word "psikologist" would still cause Turbo Lightning to suggest the correct spelling of "psychologist" because of the sound alike quality of both words. Placing the cursor on a word in the document and pressing a single key causes a list of synonyms to be displayed. Word replacement is completely automatic for both the spell checker and thesaurus. New words can be added to the spell checker's dictionary but not to the thesaurus.

Product Name:	VISTA, VISTA 2
Vendor:	TeleSensory Systems, Inc.
Address:	455 North Bernardo Avenue Mountain View, California 94043
Telephone:	(415) 960-0920
Price:	VISTA (Model SF1B) $2095.00 VISTA 2 (Model SF2A) $2495.00
Used With:	IBM PC, XT, AT, PS/2 models 30, 50 and 60 (50 and 60 require VISTA 2), HP Vectra, and 100% PC compatible computers with 100% PC compatible monochrome, CGA, EGA or VGA video display boards
Special Considerations:	The VISTA system is an internal hardware device. It takes up one slot inside the computer. Uses a mouse pointer which requires a 25 pin serial port. Most PC type computers come with a built-in serial port, but a port is simple and inexpensive ($40-50) to add if needed. Check with vendor before purchase to confirm compatibility of equipment with which VISTA will be used.
Notes:	Works well with both text and graphics. Easy to install, learn and use. Magnification adjustable from 3X to 11X (2X to 14X with VISTA 2). Large print text display is fast and smooth. Works with communications software (modems), many computer networks and terminal emulators. All commands are issued using the buttons on the mouse pointer. Adjustable scrolling rates, optional single line display,

overview mode and optional pre-set start-up settings for various display options are standard features. Automatic cursor tracking with all programs except spreadsheets. Viewing window must be manually relocated when using VISTA with spread sheet type programs (i.e., Lotus, Multiplan, SuperCalc). Only PC based large print system presently meeting Section 508 guidelines.

Adaptations for Deaf and Hard-of-Hearing Computer Users

Product Name: MindReader
Vendor: Brown Bag Software

Address: 2155 South Bascom Avenue, Suite 114
Campbell, California 95008
Telephone: (408) 559-4545

Price: $89.95

Used With: IBM PC, XT, AT, PS/2 or work-alikes

Special Considerations: MindReader requires 256K of memory and works with either monochrome, color or enhanced graphics displays. When used in combination with other software based adaptations, additional computer memory will be required. Computers equipped with 640K of memory will support MindReader and several other adaptations concurrently.

Notes: MindReader is a "smart" word processor which is able to anticipate and complete words or phrases based on their first few letters. Used with persons who have limited fine motor control, MindReader can increase typing speed by as much as 75%. The system is entirely menu driven. Most individuals are able to produce printed documents within thirty minutes after being introduced to the program. MindReader "learns" a user's word usage patterns and so becomes "smarter" with continued use. The size of MindReader's vocabulary is only limited by disk storage space. The program is a full-featured word processor including a calculator, spelling check and line drawing capability. MindReader can produce a standard ASCII text file which can be used by other word processing programs. All processing is performed in memory, so the number of pages which can be edited at any one time will be determined by available memory. A typical computer system with 256K of memory should be able to handle a 25 to 30 page document.

Product Name: Turbo Lightning
Vendor: Borland International

Address: 1700 Green Hill Road
Scotts Valley, California 95066-0001
Telephone: (408) 438-8400

Price: $99.95

Used With: IBM PC, XT, AT, PS/2 or work-alikes

Special Considerations: Requires plenty of disk storage and, when used in conjunction with other software based adaptations, a computer with 640K of memory. Although it continues to function, Turbo Lightning loses some flexibility when used with non-standard programs like Mind Reader. Although non-standard programs do not appear on the Turbo Lightning installation menu, with a little experimentation almost any program can be accommodated. When using the program with a two floppy drive system, best results will be obtained by placing the program and thesaurus files on drive A: and the dictionary files on drive B:.

Notes: Turbo Lightning is a "real-time" spell check and thesaurus. That is, it checks spelling as text is actually being entered. A tone alerts the user to probable spelling errors as they actually occur. Pressing a single key causes Turbo Lightning to display a window of likely correct spellings. Word corrections are based on sound alike words rather than similarly spelled words. For example, the incorrectly

spelled word "psikologist" would still cause Turbo Lightning to suggest the correct spelling of "psychologist" because of the sound alike quality of both words. Placing the cursor on a word in the document and pressing a single key causes a list of synonyms to be displayed. Word replacement is completely automatic for both the spell checker and thesaurus. New words can be added to the spell checker's dictionary but not to the thesaurus.

Adapted Computer Technologies Curriculum

It is useful to have some structured method for acquainting disabled students with the uses of computer access systems. This chapter describes the curriculum used in the California community colleges for five different classes which are intended to develop student profficiency in the use of adapted computer technologies. The courses are:

1. **Computer Access Evaluation**
2. **Adapted Keyboarding**
3. **Computer Access I**
4. **Computer Access II**
5. **Computer Access Projects**

Although they are listed sequentially, many students might appropriately begin with Computer Access I or even Computer Access II.

B.1

Curriculum Structure

The courses are designed to allow for flexibility in managing student flow through the curriculum. Typically, a student would be referred to the High-Tech Center by an instructor or counselor. An initial interview with the student would determine the need to begin with the Evaluation and Keyboarding courses or whether the student could proceed directly to Computer Access I.

The first two courses listed, Computer Access Evaluation and Adapted Keyboarding, provide valuable periods in which to assess the access needs of severely disabled students and develop keyboarding skills, before beginning work on word processing tasks.

Computer Access Evaluation

This course can be presented in two ways: either as a series of meetings with the student over a period of weeks or as a small number of lengthy sessions. Selection of the structure is left up to the college and/or the specialist who will be doing the evaluation.

Clearly, not all students will need to take this class. It is intended primarily to assess severely disabled students whose access needs are substantial and complex. During this course, range of motion and keyboard access evaluations might be performed, access methods identified, special systems configured, and a preliminary introduction to equipment usage begun. This course may be taken concurrently with the keyboarding class.

B.2

Adapted Keyboarding

Many students come to High-Tech Centers with poor keyboarding skills. As a general rule, it is recommended that students be referred to mainstream typing classes to learn keyboarding skills. This course is designed for those students who cannot function productively in mainstream typing courses.

This is not seen as a corequisite for Computer Access I if students have inadequate typing skills. For such students it should be a prerequisite. In that way, student participation in Computer Access I is not hampered by lack of knowledge of the keyboard.

Experience has shown that attempting to master keyboarding, an access technology, and word processing, simultaneously, is too much for students to assimilate in a productive manner.

A student who successfully completes the class will have developed touch typing skills and a basic typing rate of at least 20-25 words per minute. Students with orthopedic disabilities which prohibit typing at this rate will exit this course with a complete familiarity of all key locations.

Low vision or blind students may require specialized instruction in order to complete this course.

Computer Access I

This course introduces the student to the use of access technologies appropriate to his or her disability within the context of basic word processing.

Students who do not require the assessment or keyboarding class will usually enroll in this course first.

This is a basic introductory course and is generally not repeated. Successful students move on to varied activities in the Computer Access II course.

Computer Access II

This is the second semester of work begun in Computer Access I. Usually there are two types of course work being done in this class: advanced word processing and work with other related applications, such as database management and spreadsheet software.

Additional versions of this class can be created to meet specific software application or subject area needs.

Computer Access Projects

This course is primarily designed for larger centers. It is intended for students who have completed

High-Tech Center curriculum but need to use High-Tech Center facilities in order to compete successfully in academic course work. These students typically need assistance in learning to use access technologies in new or unusual ways.

Course Title: Computer Access Evaluation

Prerequisite/Corequisite

A student must be eligible for services and instruction from Disabled Student Programs and Services through appropriate verification of a primary disability by certificated personnel and be able to benefit from the programs and services offered by the High-Tech Center.

B.4

Class Format

Individualized assessment, by arrangement.

Units

One-half unit of credit for a total of nine hours of individualized assessment activities.

Rationale

A determination of a student's access requirements may be needed in order to determine the feasibility of that student's participation in High-Tech Center classes. The first step in this process is to ascertain whether or not a match can be made between the technological capabilities of the Center and the disabled student's access requirements.

Course Description

This course is designed to provide a means for in-depth computer access evaluation in order to determine an appropriate access environment for a student with one or more disabilities. Likely participants in this course would include (1) multiply handicapped, (2) severely physically disabled, (3) students with acquired brain injuries resulting in secondary orthopedic and/or visual disabilities, (4) re-entering disabled older students, (5) blind, or (6) other students on recommendation of the instructional staff.

Objectives

1. Through assessment and evaluation the student will be matched with the disability-appropriate adaptation in the following areas:
    a. Keyboard access
    b. General mobility and seating
    c. Cognitive processing abilities
    d. Educational goals
2. On the basis of the assessment, it will be determined if the student can be appropriately served by the access technologies available in the High-Tech Center.
3. As determined by instructor observation, the student must exhibit appropriate adaptive behavior for successful participation in the educational setting.

B.5

Course Content and Scope

Module 1: Intake interview and review of student's history including

1. Educational goals and objectives
2. Existing familiarity with computer systems, if any
3. Review of existing medical records, if appropriate
4. Review of academic records, if appropriate

Module 2/3: Diagnostic instruction where appropriate to evaluate:

1. Keyboard access capabilities
2. Mobility and seating
3. Ability to manage tasks associated with basics of access technology and computer system
    a. Can the student carry out multi-part instructions?
    b. Can the student perform physical tasks necessary for computer use; e.g., turning on the computer, inserting the disk?

Module 4: Prescriptive selection and assembly of an appropriate array of access devices based on mobility and access evaluation

Module 5: Basic introduction to and trial use of access devices. Adjustment of access devices based on student use.

Module 6: Recommendations and referrals. On the basis of the evaluations undertaken in this class, the instructor will prepare a prescriptive list of appropriate adaptive technologies and discuss the results with the student.

Module 7: Development of an Individualized Education Plan (IEP) for students who will be taking other High-Tech Center classes

Course Outline Components Not Appropriate to This Course

1. Reading and Writing Assignments
2. Outside Assignments
3. Critical Thinking

Primary Method of Instruction

Individualized assessment by the instructor

Means of Evaluation

A student will receive one-half unit of credit upon completion of the seven course modules.

Grading

The course is offered on a Credit/No-Credit basis.

Course Completion Outcome

1. Successful computer access systems are identified and the student is recommended for enrollment in High-Tech Center Computer Access I.
2. Generation of an IEP for students who successfully can use a computer through the use of adapted technologies provided in the High-Tech Center.
3. If no appropriate access technologies are available through the High-Tech Center the student is referred to other resources.

Text/Supplies Required

Items of a personal nature (e.g., mouthstick, head wand, or a unique access device) must be provided by the student.

Course Title: Adapted Keyboarding

Prerequisite/Corequisite

A student must be eligible for services and instruction from Disabled Student Programs and Services through appropriate verification of a primary disability by certificated personnel and be able to benefit from the programs and services offered by the High-Tech Center. Computer Access Evaluation may be required as a prerequisite or corequisite, if appropriate.

Class Format

This course is a lab class.

Units

This is a variable unit class. One-half unit of credit will be granted upon completion of 24 hours of lab work; or one unit of credit will be granted upon completion of 48 hours of lab work.

Rationale

Touch typing skills are useful for appropriate speed and performance in word processing tasks. This course is necessary for students who are not able to participate successfully in mainstream typing classes. Adapted computer technologies will be used in conjunction with software keyboarding tutorials.

Course Description

This course is designed to teach keyboarding basics to disabled students who (1) must use adaptive technologies for successful access to the keyboard or screen and/or (2) are unable to compete successfully in mainstream typing classes.

Objectives

1. The student will demonstrate, by the end of the course, effective use of an appropriate access technology (e.g., VISTA, Filch) if needed, in conjunction with the software program used to teach keyboarding. The student will be able to complete lessons independently.

2. The student will demonstrate key-stroking proficiency with at least one computer keyboard in order to complete the minimum requirements of this course. This key-stroking proficiency will demonstrate familiarity with the following areas:
    a. The alpha-numeric components of the computer keyboard (the QWERTY configuration)
    b. The specialized areas of the keyboard (the numeric keypad, the arrow keys, the function keys) and the special control keys (e.g., CONTROL, ALT, DELETE, CAPS LOCK)
3. The student will develop appropriate touch typing techniques on the alphabet portion of the keyboard.
4. The student will achieve a minimum typing speed of 22 words per minute with a maximum of two uncorrected errors per minute on a three-minute timed test of copy writing, in order to be recommended for further instruction and service through the High-Tech Center.*
5. For a student whose disability prevents a minimum typing criterion score, demonstration of familiarity with the physical configuration of the keyboard layout will be required. These students might typically include, but are not limited to, persons with orthopedic disabilities, neuromuscular disorders or acquired brain injury.

Course Content and Scope

Touch typing skills will be taught through the use of software tutorials. TYPIST is an example of a software program compatible with access technologies: e.g.,

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*This words-per-minute minimum criterion is that recommended in the *Keyboarding Curriculum Guidelines* published by the State of Washington in July, 1986.

VISTA, which provides access for low vision students, or Filch, which provides keyboard control for orthopedically impaired students unable to efficiently use a standard keyboard. Any keyboarding tutorial similarly compatible with access technologies may be used.

If the program TYPIST is used, the following would serve as appropriate course content.

The student will learn:

1. The keyboard layout
2. Which finger types which key
3. Good technique in keystroking
   The student will monitor keystroking activity by observing graphically displayed keystroke patterns as evaluated by the TYPIST program.
4. To keep his or her eyes on the screen
5. To develop speed in typing short sequences of keys

B.10

6. To develop accuracy in typing short sequences of keys
7. To develop speed in typing short phrases, sentences, paragraphs
8. To develop accuracy in typing short phrases, sentences, paragraphs
9. To successfully copy text for a one-minute, timed writing at a gross striking rate of at least 22 words per minute, allowing for two error words per minute.*
10. To successfully copy text for a three-minute, timed writing at a gross striking rate of at least 22 words per minute, allowing for two error words per minute.*

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*These timed writings will be administered by the instructor; they are not a part of the TYPIST program.

Course Outline Components Not Appropriate to This Course

1. Readings and Writing Assignments
2. Outside Assignments

Critical Thinking

Critical thinking is inherent in working through a program of instructional software in which a student must make choices based on the results of previously completed activities. Because this is a step-by-step process, it is called a sequenced software program.

In order to proceed successfully through a sequenced program, a student must deduce which menu option is most appropriate upon completion of a task, if there are no other specific instructions or procedural indicators. To do this, the student must analyze and evaluate his performance on the task just completed and must use deductive reasoning to make the most appropriate menu choice.

Primary Method of Instruction

Instructor-supervised computer assisted instruction in a lab setting.

Means of Evaluation

A student's familiarity with the keyboard will be measured by performance on timed typing tasks. The student will achieve a minimum stroking rate of 22 words per minute with a maximum of two uncorrected errors per minute on a three-minute, timed test of copy writing.

In some instances, the instructor may decide that a student's disability legitimately prevents him or her from reaching the target minimum speed. For such a student, demonstration of obvious familiarity with the physical keyboard should be the factor determining successful completion of the class.

Students who are unable to meet the target minimum speed, and who have no mitigating disabling condition, could be regarded as not yet ready for High-Tech Center classes.

Grading

This course is offered on a Credit/No-Credit basis.

Course Completion Outcome

Assuming the absence of intervening disabilities, the student will, upon successful completion of this course, demonstrate touch typing skills and a basic typing rate of at least 22 words per minute with a maximum of two uncorrected errors per minute. The student may demonstrate a familiarity with more than one type of computer keyboard.

Texts/Supplies Required

None

Course Title: Computer Access I

Prerequisite/Corequisite

1. A student must be eligible for services and instruction from Disabled Student Programs and Services through appropriate verification of a primary disability by certificated personnel and be able to benefit from the programs and services offered by the High-Tech Center.
2. Successful completion of and referral from the Computer Access Evaluation class may be required.
3. Adapted Keyboarding is required as a prerequisite if a student does not have adequate touch typing skills (approximately 20 wpm).

Note: Touch typing skills are not required for a student with orthopedic disabilities, but such a student must have an established, independent means of accessing the keyboard.

Class Format

Lecture, two hours per week with 1-2 hours of lab per week

Units

Two units of credit are allowed. (Three units can be earned if 48 hours of lab time are completed.)

Rationale

In order to participate successfully in post-secondary education, access to microcomputers is extremely useful for students with disabilities. Since written communication is a primary requirement for success in both academic and job-related environments, the course introduces the use of specialized computer access systems within the context of word processing.

Course Description

Designed for students with visual, physical, learning disabilities, hearing loss, or deafness, this course provides training in the use of computer access technologies which enhance a disabled student's ability to access and use microcomputers.

Training in the use of computer access technologies will occur in the context of word processing. The course will familiarize students with basic concepts of word processing used by the majority of industry-standard word processors, e.g., WordStar, WordPerfect.

Objectives

1. Evaluation and selection of access technologies appropriate to the student's disability if the student has not completed the Computer Access Evaluation class.
2. Instruction in the use of access technologies appropriate to the student's disability in the context of word processing. Specialized areas of instruction might include, but not be limited to, individual and/or small group instruction in the use of:
    a. MindReader
    A specialized word processing environment for moderately to severely orthopedically disabled, learning disabled, and deaf or hard-of-hearing students.
    b. Turbo Lightning or Coach Professional
    A continuous, real-time spell-checker and thesaurus for use by all disability groups.
    c. Vista/NicePrint or InLARGE
    Hardware and software for large text on computer screen and from printer for low vision or learning disbled students.
    d. DECTalk/Freedom1/Outspoken
    Screen reading and speech output for the blind, low vision or learning disabled.
    e. Filch or Easy Keys
    Keyboard adapter for physically disabled, learning disabled, low vision or blind students.
    f. Keytronics KB5153 Keyboard
    Specialized keyboard for use by physically or learning disabled persons.

Course Content and Scope

The total instructional period for use of specialized access devices will be four weeks. The remainder of the semester will be spent in using the access technology in the context of word processing.

It is anticipated that blind students will require the entire four weeks for beginning efficiency with screenreading techniques. Moderately physically disabled students students will require two weeks to develop beginning proficiency with their specific access technology; all other students will require approximately one week to develop beginning proficiency.

Upon achievement of beginning competency levels with appropriate access technologies, students will use the balance of this initial four-week period to review computer keyboarding skills through the use of computer-assisted tutorials. Within the remaining 12 weeks, the following competencies will be acquired in the approximate time periods listed.

Weeks 1-4: The student will develop competency in a specialized access adaptation and review basic keyboarding skills.

Week 5: The student will become familiar with basic use of microcomputers in conjunction with specialized computer access systems.

The student will understand and appropriately perform:

1. Disk handling
2. Basic startup procedures
3. Basic DOS commands

Week 6: The student will be able to understand and define the following word processing concepts and structures.

1. Word processing
2. File
3. Document

4. Word wrap
5. Edit
6. Format
7. Pagination
8. Spelling check
9. Data disk/program disk

Weeks 7-9: Using appropriate adaptive technology, the student will be able to open or edit a document and use the following basic word processing procedures.

1. Move cursor to any point on screen
2. Erase, insert and edit text
3. Change margins, line spacing and tab settings
4. Move marked blocks of text within document
5. Print a file
6. Save and retrieve word processing documents

B.16

Weeks 10-16: The student will successfully apply computer access technologies and basic word processing skills in creating and editing.

1. Business letter format
2. Memo format
3. Essay format
4. Outline format

Week 17: Course review

Week 18: Final exam

Reading and Writing Assignments

1. Students will read chapters from assigned text

2. Students will complete many writing assignments in the context of word processing tasks. Examples:
   a. Content appropriate to a business letter
   b. A tutorial manual which details basic word processing commands and tasks
   c. Short essays on specified subjects

Outside Assignments

Readings in the assigned text.

Critical Thinking

Critical thinking is involved in the successful execution of all computer tasks; e.g., which command is appropriate to which situation.

Examples of specific projects which require critical thinking:

1. Students will independently solve unfamiliar problems: students will be given a "jumbled" file and will reassemble it into an appropriate form matching hard copy by using word processing commands (e.g., block moves, deletions). Students will not reassemble the file by simply typing in the correct form.
2. Students will apply principles of editing in a word processor by editing a severely misspelled and poorly produced file. Students will be expected to analyze word usage and, if necessary, determine the semantically correct word as spelling is corrected. Students will observe standard typing format protocol in the editing of this file.
3. Topics for text production necessary to complete word processing tasks will require critical thinking skills: e.g., clarifications, new solutions, evaluations, comparisons.

4. The student is expected to prioritize steps to complete assignments within the alloted lab time. Where applicable, the student is expected to apply concepts learned in this class to assignments for other classes.

Method of Instruction

This class will be conducted on a small group or individual basis.

Means of Evaluation

Grades are arrived at as follows:

30%	Class assignments
20%	Quizzes
20%	Midterms
30%	Final

Typical examinations will require a knowledge of word processing commands and the actions they perform.

Students will also be evaluated on the successful completion of "hands-on" tasks given as evaluation measures.

Grading

This course is offered on a Credit/No-Credit basis.

Course Completion Outcome

Upon successful completion of this course, the student will be familiar with the access devices appropriate to his or her disability and will demonstrate knowledge of basic word processing skills.

Text/Supplies Required

A basic college-level word processing text for the specific word processor used is required. Students are requested to provide two floppy disks.

Items of a personal nature (such as a mouth stick or head wand or a unique electronic access device) must also be provided by the student.

Course Title: Computer Access II

Prerequisite/Corequisite

A student must be eligible for services and instruction from Disabled Student Programs and Services through appropriate verification of a primary disability by certificated personnel and be able to benefit from the programs and services offered by the High-Tech Center.

Instructor approval and successful completion of Computer Access I is necessary. The instructor may directly refer a student to Computer Access II if the student has had prior experience with access technologies and exhibits adequate touch typing skills.

Class Format

Lecture, two hours per week, plus 1-2 hours of lab per week.

Units

Two (or three with a total of 48 hours of lab work).

Rationale

This course is designed to further refine computer access skills. Students who have completed Computer Access I may have developed only a beginning competency in their prescribed access technologies and will require additional instruction in order to fully utilize their access systems.

Course Description

This course is designed for disabled students who have successfully completed Computer Access I. Students will enhance their computer access skills through the completion of assignments or projects.

Objectives

Objectives will be individualized and based upon student educational/vocational objectives. Possible objectives are stated below.

For students pursuing advanced word processing tasks: The student will demonstrate skill in the use of a computer access application in the context of advanced word processing tasks such as mailmerge functions, columnar block moves, editing multiple documents, advanced formatting and stylistic techniques which require sophisticated knowledge of a particular access device.

For students learning other software applications: The student will develop competency in the use of an adapted computer application in conjunction with such widely used computer programs as spreadsheets, database managers, accounting systems or computer assisted design.

Course Content and Scope

Course content will depend upon the unique access needs of the student and type of skills to be developed by the student. Typical examples of course modules could include one or more of the following:

1. Development and refinement of screenreading skills for blind students. This might include a sequence of activities encompassing screen reading techniques for advanced word processing applications or other software programs.

2. Development and refinement of access skills for low-vision students in the context of visually intensive software applications such as spreadsheets or desktop publishing.
3. Further basic access skills development for students with extremely slow text entry capabilities (head wand or mouth stick keyboard entry, or limited manual entry) in the context of word processing or other applications.

Reading and Writing Assignments

1. Students will be assigned readings from required texts as needed to learn new applications.
2. Writing assignments are components of almost all word processing tasks.

Outside Assignments

Assignments will consist largely of projects and studies from other classes in which the student is concurrently enrolled. The completion of these assignments and studies will require the learning of new and advanced skills in the use of adapted computer technologies.

Critical Thinking

Critical thinking skills are involved in all activities of this class. Students will be required to synthesize new information and apply it to known and new situations as they develop skills in using their access technology in the context of new applications. (Example: A student will develop an instructional manual describing the use of his/her access device in conjunction with a new computer application.)

Method of Instruction

This class will be conducted primarily on an individual and small group lecture/lab basis.

Means of Evaluation

30%	Class assignments
20%	Quizzes
20%	Midterms
30%	Final

Example: A blind student will be given a final exam on disk. The exam will require the student to deduce that he or she must apply advanced screen reading techniques in order to appropriately complete the assigned task (e.g., the need to read the file directory at the opening menu and the need to read large or small menus while working in a file).

Grading

This course is offered on a Credit/No-Credit basis.

Course Completion Outcome

Upon successful completion of this course the student will demonstrate sophisticated access skills, in conjunction with advanced word processing or other software applications, as well as the ability to apply these skills to new and novel situations.

Text/Supplies Required

Student supplies his/her own disks. Texts as required by type of computer access project.

Course Title: Computer Access Projects

Prerequisite/Corequisite

A student must be eligible for services and instruction from Disabled Student Programs and Services through appropriate verification of a primary disability by certificated personnel and be able to benefit from the programs and services offered by the High-Tech Center.

Instructor permission is required. It is expected that students who enroll for this class will be able to work independently in the lab and will require instructional support only for new aspects of the access technology which they are employing.

Class Format

This course is a lab project course.

Units

This is a variable unit course; one unit of credit will be granted upon completion of 48 hours of lab work. One-half unit of credit will be granted upon completion of 24 hours of lab work.

Rationale

This course is designed for students who have completed the regular High-Tech Center curriculum and who must learn new and advanced areas of their adapted technologies in order to complete other classroom assignments or special projects.

Course Description

This course is designed for students who require access to specialized adaptive technologies in order to complete assignments for other classes in which they are concurrently enrolled.

Course Objectives

1. The student will learn new skills associated with highly specific applications of his/her access technology.

2. The student will acquire advanced problem-solving skills in the use of his/her access technology.

Course Content and Scope

1. The student will meet with the instructor to discuss the project which the student wishes to complete.
2. Based on this student/instructor discussion, the instructor will determine the validity of the project and what new aspects of the student's access technology must be taught within the scope of this assignment.
3. The student will complete a contractual agreement which details the work to be done, the ACT assistance to be required, and the estimated length of time needed to complete the assignment.

Basic instruction will involve new applications of access technologies used in the High-Tech Center. Applications will vary from student to student.

Typical examples of such work would be a low vision student learning to use access technologies with software required for an accounting class; or, a blind student using a screen reading program to develop complex screen layouts for a course in poetry composition.

Critical Thinking

Critical thinking is directly involved in the successful completion of all aspects of work for this course. The ability to work independently without requiring specific instruction except in the new use of the access technology is a demonstration of use of critical thinking skills.

Method of Instruction

This class will be conducted on a lab basis.

Means of Evaluation

Completion of class project and mastery of new access applications as described in the student/instructor contractual agreement.

Grading

This course is offered on a Credit/No-Credit basis only.

Course Completion Outcome

The student will have successfully used his or her type of adaptive technology in a new context.

Text/Supplies Required

Student must provide his/her own disk.

Section 508 Legislation

ACCESS TO INFORMATION TECHNOLOGY BY USERS WITH DISABILITIES

INITIAL GUIDELINES

OCTOBER 1987

C.1

On October 21, 1986, the Department of Education (ED) and the General Services Administration (GSA) were directed by Congress (Public Law 99-506) to develop agency procurement guidelines to ensure access to electronic office equipment by individuals with disabilities. This report presents initial management and procurement guidance to federal agencies. It was developed jointly by DOE and GSA in consultation with an advisory committee and individuals from the electronics industry, agencies, and the disabled community. The principal authors of this report were:

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EXECUTIVE SUMMARY

In 1986, Congress mandated that agencies formally assume responsibility for ensuring that electronic office equipment, whether purchased or leased, be accessible by individuals with disabilities. This document details the implementation plan for this statute (Section 508, P.L. 99-506) together with the initial management and procurement guidance to agencies regarding electronic equipment accessibility. This guidance also provides early information to industry regarding the direction in which the government is moving.

Significant productivity and human resource benefits accrue to government, industry, and individuals with disabilities when standard information technology can be readily enhanced to support all users. Current microcomputers can be adapted to accommodate the special access requirements of most users with disabilities. In addition, many emerging access technologies used by individuals with disabilities today e.g., voice input/output and enhanced keyboard and monitor capabilities, may be beneficial to all users as the technologies mature.

In 1984, the National Institute on Disability and Rehabilitation Research of the Department of Education (ED) established a Government-Industry Task Force to identify ways of designing computers to make them usable by a larger portion of the population. Also in 1984, the General Services Administration (GSA) established the Interagency Committee for Computer Support of Handicapped Employees and the Clearinghouse on Computer Accommodation to advance the management and use of information technology in order to promote the productivity and achievement of Federal employees with disabilities.

These joint ED and GSA guidelines reflect the firsthand experiences of these agencies during the past three years, as well as consultation with the electronics industry, other agencies, and the disabled community during guidelines development. The guidelines address management responsibilities and functional performance specifications for achieving accessibility. It is anticipated that these guidelines and all related activities will continue to evolve in the years ahead as information technology advances and as the government gains additional experience in applying technology to meet the requirements of individuals with disabilities.

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C.7

I. INTRODUCTION

In 1986, Congress re-authorized the Rehabilitation Act of 1973, as amended, (Public Law 99-506) adding Section 508 on electronic equipment accessibility "… to insure that handicapped individuals may use electronic office equipment with or without special peripherals." Congress has mandated that guidelines for electronic equipment accessibility be established and adopted and that agencies shall comply with these guidelines with respect to electronic equipment, whether purchased or leased.

The initial guidelines that follow address management responsibilities for electronic equipment accessibility and functional performance specifications. The guidelines interpret Congress' intent to mean that future Government procurements and leasing of equipment shall assure electronic accessibility such that: the disabled end user shall have access to the same data bases, operating, and application programs; shall be equipped with adaptive programs and devices to support his or her disabilities; shall have computing capability not appreciably less than that of non-disabled end users in the same position and office; and shall be supported in manipulating data so as to attain end results equivalent to the non-disabled user. Electronic equipment which is part of a telecommunications system shall permit disabled end users to transmit and receive messages in a form amenable to their disabilities and having a content comparable to messages transmitted by non-disabled end users.

The above shall apply to all Government agencies, and an agency's lack of accessible electronic office equipment shall not be a rationale for denying employment, promotion, or transfer.

To achieve the intent of Congress, the Government shall establish accessibility policies and procedures for planning, management, procurement, and compliance which complement current information resources management activities, and management practices generally. This first version of the guidelines is an initial step. It is intended to set a tone and to provide early guidance to industry on the direction in which the Government plans to move in the months and years ahead. As experience is gained, and as technology emerges, these guidelines will continue to evolve.

Providing electronic equipment accessibility for individuals with disabilities who have special needs is an idea whose time has come. Of all the electronic office equipment technologies, microcomputers may have the greatest current and long term potential for individuals with disabilities. While many individuals with disabilities will not need special equipment, others will. Due to the inherent flexibility of microcomputer technology, many users with vision or motor impairments, who cannot benefit from commonly used computer displays or keyboards, have alternatives readily available e.g., large print and braille displays, spoken input and output, and keyboard enhancement and replacement products. Fueled by this potential of microcomputer technology in the office, there is action in many areas.

Executives and others working independently in central agencies, line agencies, in Congress, and in industry have taken important actions to begin to provide electronic equipment accessibility to individuals with disabilities. The Rehabilitation Act of 1973, as amended, is serving as a catalyst to provide a comprehensive and longer range view of the possibilities.

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II. BACKGROUND

In 1984, the National Institute on Disability and Rehabilitative Research (NIDRR), the Office of Special Education and Rehabilitative Services, Department of Education, in conjunction with the White House, took the initiative to begin a process of bringing computer manufacturers, developers, and consumers together to address the question of access and use of standard computers and computer software by persons who have disabilities.

An initial meeting was held on February 24, 1984, at the White House. The objective of the meeting was to familiarize the companies with access problems and to solicit their support in a cooperative effort to address the problems. The meeting resulted in recognition of the problems, and a request by the manufacturers for more information about disabilities, current barriers to the use of standard computers, and solution strategies that the manufacturers should consider.

Subsequent to this meeting, briefings were held with manufacturers, and a White Paper was developed and distributed in preparation for a second meeting on October 24-25, 1985. This meeting consisted of a one and one-half day work session followed by a reporting session at the Rayburn Building on Capitol Hill. Computer firms represented included Apple, AT&T, Digital Equipment Corp., Hewlett Packard, Honeywell, IBM, and Tandy Corporation.

As a result of this second meeting, a Government/industry task force was formed. Now, two years later, the task force continues to work to identify ways that industry can improve the design of computers so that they will be usable by a larger portion of the population.

Additional information about task force achievements and participants is available from NIDRR.

III. AUTHORITIES AND RESPONSIBILITIES

Section 508 of Public Law 99-506 places new responsibilities on the Department of Education and the General Services Administration. These new responsibilities along with related responsibilities from earlier legislation include:

> Department of Education—"The Secretary, through the National Institute on Disability and Rehabilitation Research (NIDRR) and the Administrator of the General Services, in consultation with the electronics industry, shall develop and

> establish guidelines for electronic equipment accessibility designed to insure that handicapped individuals may use electronic office equipment with or without special peripherals." The deadline for establishing the initial guidelines is October 1, 1987. The guidelines are to be periodically revised as technologies advance or change.
>
> General Services Administration—The Administrator of GSA, under the Federal Property and Administrative Services Act of 1949, as amended, publishes and codifies uniform policies and procedures pertaining to information resources activities by Federal or executive agencies (as applicable) and by Government contractors as directed by agencies. Under Section 508 of Public Law 99-506, the Administrator of GSA will assist the Secretary of Education in the development of the guidelines noted above. In addition, the Administrator is charged with adopting guidelines for electronic equipment accessibility after September 30, 1988.

Section 508 of P.L. 99-506 refers to "electronic equipment, whether purchased or leased," directs the ED and GSA to develop electronic accessibility guidelines, and then directs GSA to adopt the guidelines "for Federal procurement of electronic equipment." Procurements initiated after September 30, 1988, shall comply with the guidelines.

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IV. PURPOSE

This document has five purposes:

1. Identify the recent activities in this area
2. Provide a broader framework for meeting the needs of individuals with disabilities now and in the future as the electronics industry advances
3. Provide guidance to agency management in determining the needs of end users with disabilities and acquiring electronic equipment to satisfy these needs

4. Detail the implementation plan for Public Law 99-506, Section 508, on Electronic Equipment Accessibility
5. Encourage industry to meet the needs of the disabled community through standard products, over the longer term

V. CURRENT RESOURCES

In recent years, many individuals have initiated independent action to assist individuals with disabilities to capitalize on the potential of electronic office technology. The Government currently has the following resources and interested parties should contact the programs directly. In March 1984, the Administrator of GSA established the Interagency Committee for Computer Support of Handicapped Employees (ICCSHE). Twenty-three agencies are represented on the committee. They meet quarterly to exchange information on progress and problems in advancing Information Resources Management (IRM) activities to support employees with disabilities. Half of the member agencies have completed internal directives establishing general policy and procedures for providing computer support to their handicapped employees. The directives establishing this responsibility within their IRM offices were modeled after an internal order that established a similar responsibility within GSA and also created a Governmentwide Clearinghouse on Computer Accommodation (COCA).

ICCSHE assists GSA by developing proposals addressing management and procurement areas where attention and guidance is suggested. Through four working groups, ICCSHE, sponsors annual Governmentwide symposia, collaborates with federal laboratories to facilitate technology transfer, and participates in exchanges with counterpart organizations in other countries.

Individual agencies are implementing computer support activities and sharing their accommodation solutions with COCA, which serves as a central point of information exchange and networking among agencies. Examples of some ongoing agency activities follow.

The Department of Defense (DoD) has established Coordinators for Computer Support of Handicapped Employees in each major DoD component. The Office of the Assistant Secretary of Defense, Force Management and Personnel is responsible for this initiative.

A Computer Support Committee has been formed at the Department of Health and Human Services and special funds for purchases of accommodation technology are being set up within the services. The Social Security Administration has established a Special Terminal and Adaptive Resources (STAR) Project as part of their Systems Modernization Plan. A task force is working to provide accommodation equipment that will allow disbled employees in all field offices to use the new automated claims system.

The Information Technology Center (ITC, FTS 233-5525) of the Veterans Administration has developed a program to enable their disabled employees to use personal computers. Through interagency agreements, consultation and training are also available to employees of other Federal agencies.

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The Internal Revenue Service is developing a requirements contract for accommodation-related equipment, technical staff are available to assist with accommodation needs, and strategies are being reviewed to improve access to print information by visually impaired employees. GSA's Clearinghouse on Computer Accommodation (COCA, FTS 523-1906) was established in January 1985. This technical resource center assists agencies as they establish support services and responds to individual accommodation requests Governmentwide. COCA provides demonstrations of accommodation products and strategies at their center, 18th and F Streets, N.W., Washington, D.C. In addition, COCA gives presentations at agency conferences and seminars and provides formal training in computer accommodation through the GSA Training Center. COCA also maintains a data base of accommodation solutions received from agencies. Several agencies are implementing COCA's data base program to maintain their own inventory of agency equipment and expertise. COCA is currently preparing a manager's handbook, Managing End User Computing for Users with Disabilities, that will be published in November 1987.

On April 27, 1987, GSA published Bulletin 48 in the Federal Information Resources Management Regulations System (FIRMR). This outlines the responsibilities of agencies to provide for the special computer accommodation needs of employees with disabilities when replacing existing computer systems. In the future, GSA plans to consider the development of a schedule of contractors to assist agencies when they need help to integrate end users with disabilities into the information technology environment.

In summary, there is a great deal of activity which has preceded and led to these guidelines. We anticipate that these guidelines and all other activities will continue to evolve in the years ahead as technology improves and as the Government gains further experience in adapting technology to the special needs of individuals with disabilities.

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VI. GUIDELINE PROPOSALS

These proposals address management responsibilities for electronic equipment accessibility and functional performance specifications for input, output, and documentation. Under the law, each agency must provide electronic equipment accessibility as detailed in the guideline proposals after they are adopted by GSA.

A. Definitions

1. Electronic Equipment Accessibility—is defined as the application/configuration of electronic equipment in a manner that accommodates the functional limitations of individuals with disabilities so as to promote productivity and provide access to work-related and/or public information resources.

2. Federal Information Resources Management Regulations (FIRMR)—are regulations promulgated by GSA

that address the management, acquisition, and use of certain automatic data processing equipment, records and telecommunications resources by Federal and executive agencies.

3. Handicapped Individuals or Individuals with Disabilities—means individuals with impairment(s) that result in a functional limitation with regard to the use of electronic office equipment.

4. Special Peripheral—is defined in Section 508 as "a special needs aid that provides access to electronic equipment that is otherwise inaccessible to a handicapped individual."

B. General Policy

Handicapped persons and persons who are not handicapped shall have equivalent access to electronic office equipment. Provision of equivalent access shall include but shall not be limited to:

Ensuring that end users with disabilities can access and use the same data bases and applications programs as other end users; *C.15*

Ensuring that end users with disabilities shall be supported in manipulating data and related information resources to attain equivalent end results as other end users; and

Ensuring that when electronic office equipment is part of a telecommunications system, that end users with disabilities can transmit and receive messages in a manner that supports their disability related needs and provides the capability to communicate with end users on their system.

C. Management Responsibilities

The single official for Information Resources Management, under the Paperwork Reduction Act of 1980, should assign an individual the responsibility to implement these guidelines. This individual would be responsible for keeping the agency in step with Federal policies as they evolve over time. This would include making agency IRM and procurement managers aware of their responsibilities, building accessibility requirements into procurements, and ensuring that technical support capabilities are available to introduce new equipment. The single official should ensure that appropriate progress is being made through triennial review program inspections.

To assist agencies to perform these responsibilities, GSA is developing a manager's handbook, Managing End User Computing for Users with Disabilities, which identifies the range of disabilities and current strategies to augment computer systems for accessibility. The greater need, however, is to encourage agencies to identify the requirements of their users with disabilities in order to achieve solutions during acquisition planning and procurement. The functional performance specifications below will help address this need.

D. Functional Performance Specifications

C.16 The functional performance specifications which follow are a combination of accessibility strategies which exist today, and additional strategies that would improve accessibility in the future. They are not an exhaustive list. The purpose of the specifications is to define an initial and basic level of accessibility, to be modified over time, to ensure that information technology, leased or purchased, is available to users with disabilities. Many of these specifications will prove useful to all end users.

Depending on the needs of the end users of each agency, all or part of these specifications will be included in agency procurement documents as requirements for demonstrable features. The Government will welcome vendor creativity in responding to the functional requirements. In keeping with Federal procurement policy, each vendor will determine how to best satisfy these requirements. Vendor solutions may range from third-party hardware and software provided capabilities to hardware "built-ins" and operating system enhancements. Solutions residing in the vendors' hardware and software will have the greatest value to Government. Layering, which is the inclusion of additional levels of software between the end-user and the operating system or other general purpose software, may provide the necessary functional solutions today, but in the future could adversely impact the ease of maintaining software currency at the operating system level, reduce the mobility of the employee(s) to utilize equipment at different sites within an agency, and result in additional expense. As a result, vendors proposing layered solutions should recognize the Government trend in this area. Layered solutions will be evaluated on a case by case basis to determine their effect on the overall information processing needs of the agency.

In an era of increasing dependence on screen graphics and graphic images, our emerging requirement is to utilize established standard industry code from which screen information can be extracted, interpreted, and presented in speech or tactile form. This requirement recognizes the economic need to maintain the usefulness of all our trained human resources without permitting technology growth to exclude any class of users.

To accommodate future employees and provide systems support for current employees, solicitations should request pricing (perhaps on an hourly call-in availability basis throughout the life of the contract) for the services of vendor systems engineers who will be available to advise, assist, and resolve any communications or interfacing problems implicit in providing electronic office equipment access.

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In the future, it is the Government's expectation that emerging functional and technical specifications may be provided in the standard product line. The specifications may also evolve, with experience to become Federal standards. Initially, industry should consider the specifications as indicators of current and future functional requirements for information technology equipment. It is recognized that some of the specifications are complex and/or require research and development. These draft specifications may be amended after the public comment period.

The specifications below are organized by functional requirement(s) associated with input, output, and documentation. This organization reflects the major areas that need to be addressed during agency acquisition planning and procurement. Managers who are determining accommodation strategies for an individual employee with a disability should consult the GSA manager's handbook, Managing End User Computing for Users with Disabilities or call COCA or ITC for assistance.

1. Input

Access problems concerning the input interface to a microcomputer differ by the type and severity of the functional limitation of the employee. Some users with disabilities are capable of using the keyboard if it can be modified slightly. Users with more severe disabilities require an alternate input strategy.

a. Modified Standard Keyboard Controls

The minimum access requirement for users of a modifiable, but standard keyboard, could be achieved by providing the following capabilities:

(1) Multiple Keystroke Control. Currently there are numerous common functions on the computer that require multiple, simultaneous keystrokes (e.g., to reboot CTRL + ALT + DEL must all be depressed at the same time). Multiple keystroke control would enable the user to execute a sequential option in which multiple keystrokes could be entered serially (e.g., to reboot a user could depress CTRL, then ALT, then DEL).

(2) Keyboard Repeat Rate. Currently the computer generates repetitions of a character if the key is held down. This is a problem for those users without sufficent motor control of their fingers to conform to the repeat tolerances of the keyboard. This feature would give the user control over the repeat rate. The user could extend the keyboard tolerances or turn off the repeat function completely.

(3) Input Redundancy. Currently numerous programs use a mouse as one of the input options. As the use of graphics increases so will dependence on the mouse as an input device. Some users with motor disabilities cannot use a mouse.

This feature would provide an emulation of the mouse using the keyboard and/or other suitable alternative input devices, e.g., joy stick, trackball, voice input, and touchpad. In effect, any movement control executed through the mouse could also be executed from alternative devices.

(4) Toggle Keystroke Control. Currently toggle keys are employed which require visual feedback to know if a key is on or off. This feature would provide an alternative mode that does not require visual feedback to know the status of any toggle key.

b. Alternative Input Device

The capability to connect an alternative input device would be available to the user who is not able to use a modified, but standard keyboard. This feature would supplement the keyboard and any other standard input system used. The alternative input capability would consist of a physical port (serial, parallel, game, etc.) or connection capability so that an accommodation aid could augment the keyboard or replace it. The computer would regard this device as its keyboard and the user would be able to input any valid keystroke combination (e.g., CTRL + ALT + DEL) available from the regular keyboard. This alternative input capability would also support the mouse emulation described above.

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c. Keyboard Orientation Aids

There are several different keyboards available for current personal computers. To orient a visually impaired user to a particular keyboard, a set of tactile overlays should be available to identify the most important keys (e.g., ESC, ENTER, CTRL, ALT, and several key letters and numbers). The tactile overlays might be keycap replacements or transparent sticky tape with unique symbols to identify the various keys. To assist a motor disabled user, a keyguard should be available to ensure that the correct keys are located and depressed. A keyguard is a keyboard template with holes corresponding to the locations of the keys.

2. Output

Output in this section will address auditory output capability and monitor display.

a. Auditory Output Capability

The auditory output capability on current personal computers is sufficient to beep and play music. Some users with disabilities, however, may require speech capability. For speech to be generated on today's computers, a speech synthesizer is required. The capability to support a speech synthesizer must continue to be available in future generations of computers or this capability must be internalized through an upgrade of the computer's internal speaker. Regardless of the methodology chosen, the volume should be adjustable by the user and a headset jack should be available.

b. Information Redundancy

Currently, several programs use the speaker to beep warnings or errors to the user. Some programs do not have the capability to present the warning visually to the hearing impaired user. This feature would allow the user to have information redundancy by presenting a visual equivalent of the beep on the monitor. This might be accomplished by either a manual screen indicator (i.e., the user would have to indicate that he has seen the warning indicator by entering a key sequence to remove the indicator from the screen) or an automatic screen indicator (i.e., the warning would be presented for a period of time and then removed automatically).

c. Monitor Display

The requirement to enhance text size, verbally reproduce text, or modify display characteristics is crucial for some users with disabilities. To ensure that this access continues the following capabilities are required:

(1) Large Print Display. This feature increases the size of a portion of the screen for the low vision user. The process might use a window or similar mechanism that allows magnification to be controlled by the user. The user could invoke the large print display capability from the keyboard or control pad for use in conjunction with any work-related applications software. If applications software includes graphics, then enlargement of graphics should also be available.

(2) Access to Screen Memory for Text. The capability to access screen memory is necessary to support the speech and/or tactile braille output requirement of many blind users. Currently, blind users are able to select and review the spoken or braille equivalent of text from any portion of the screen while using standard application software. The access to the contents of the screen must continue to provide third party vendors the ability to direct it to an internal speech chip, a speech synthesizer on a serial or parallel port, or a braille display device.

(3) Access to Screen Memory for Graphics. Information that is presented graphically also needs to be accessed from screen memory in such a manner that as software sophistication improves, it may eventually be interpreted into spoken output.

(4) Cursor Presentation. Where cursors or other indicators on the screen blink, the end user should be able to adjust the blink rate. This feature accommodates persons with seizure disorders who may be sensitive to certain frequencies of flashing light.

(5) Color Presentation. Where colors must be distinguished in order to understand information on the display, color-blind end users should be able to select the colors displayed.

3. Documentation

The vendor will maintain a copy of all current user documentation on a computer, and will be responsive in supplying copies of this documentation in an ASCII format suitable for computer-based auditory screen review or brailling.

VII. IMPLEMENTATION

To develop and implement these guidelines several actions have been and are planned by GSA and NIDRR.

1. A consultant was employed to develop broad strategic concepts.
2. In May 1987, 23 companies were requested to provide input to assist in the development of the guidelines.
3. On June 29, 1987, a second letter and the first draft of the guidelines were sent to the same companies that received the initial letter. Comments were requested.
4. A two day conference was held on July 15-16, 1987, to discuss the concepts. Representatives from Government, industry, and the disabled community participated in the conference.
5. GSA and NIDRR worked together to prepare this guidelines document.
6. An advisory committee was convened on August 25, 1987, to help improve this document. ICCSHE also serves in an ongoing advisory capacity.
7. On September 30, 1987, this document will be released to provide early guidance to agencies.
8. Beginning in October 1987, agencies will be invited to work with GSA and NIDRR to implement the guidelines on a pilot basis.
9. In mid-1988, GSA will release a version of the guidelines for comment by agencies, vendors, and employees with disabilities.

10. In the remainder of fiscal year 1988, GSA will reconcile comments, and seek a consensus on the form of the FIRMR regulation and bulletin.
11. On September 30, 1988, GSA will publish the FIRMR regulation and bulletin.
12. GSA and NIDRR will work together over the years to complete the actions identified in the "Current Resources" section of this document.
13. GSA and NIDRR will work together after 1988, to update the FIRMR regulation and bulletin as the technology improves and as Government and industry learn more about providing computer accessibility to employees with disabilities. ICCSHE will continue to serve in an ongoing advisory capacity.
14. A forum will be scheduled for December 1, 1989, with federal managers, vendors, and disabled employees to review the first year's experiences.
15. The advisory committee will be reconvened on April 1, 1990, to assess the September 30, 1988, issuances relative to the current technology.

APPENDIX A
PUBLIC LAW 99-506—OCTOBER 21, 1986
100 STAT. 1807 99th Congress

AN ACT

To extend and improve the Rehabilitation Act of 1973. Section 603. ELECTRONIC EQUIPMENT ACCESSIBILITY.

(a) ELECTRONIC EQUIPMENT ACCESSIBILITY.—Title V of the Act is amended by inserting after section 507 the following new section:

"ELECTRONIC EQUIPMENT ACCESSIBILITY"

"Section 508. (a)(1) The Secretary, through the National Institute on Disability and Rehabilitation Research and the Administrator of the General Services, in consultation with the electronics industry, shall develop and establish guidelines for electronic equipment accessibility designed to insure that handicapped individuals may use electronic office equipment with or without special peripherals.

"(2) The guidelines established pursuant to paragraph (1) shall be applicable with respect to electronic equipment, whether purchased or leased.

"(3) The initial guidelines shall be established not later than October 1, 1987, and shall be periodically revised as technologies advance or change.

"(b) Beginning after September 30, 1988, the Administrator of General Services shall adopt guidelines for electronic equipment accessibility established under subsection (a) for Federal procurement of electronic equipment. Each agency shall comply with the guidelines adopted under this subsection.

"(c) For the purpose of this section, the term 'special peripherals' means a special needs aid that provides access to electronic equipment that is otherwise inaccessible to a handicapped individual."

C.24 "(b) CONFORMING AMENDMENT.—The table of contents of the Act is amended by inserting after item "Sec. 507." the following new item:

"Sec. 508. Electronic equipment accessibility."

About the Author

Carl Brown is Director of the Office of Adapted Computer Technology for the California Community Colleges Chancellor's Office and Director of the High-Tech Center for the Disabled. In 1979 he established the Carmel Unified School District's first computer courses and went on to organize and direct the computer science program at The York School in Monterey in 1981-85. In 1983 Mr. Brown established the first High-Tech Center for the Disabled, at Monterey Peninsula College, and recently received a grant from the U.S. Department of Education, Fund for the Improvement of Postsecondary Education, to continue his innovative work in adapted computer technology. He is the President of ComputerTalk, a computer consulting firm, and is the author of a series of college textbooks on microcomputers published by Brooks/Cole Publishing Company. Mr. Brown has presented at numerous national conferences on high technology for the disabled.

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